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## **The impact of agro-food imports from Ukraine on the Romanian market: a post-conflict economic analysis**

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**Abstract.** *The conflict between Russia and Ukraine has had a significant impact on agri-food markets in Eastern Europe, leading to a reconfiguration of trade routes and increased imports from Ukraine. This study analyzes the effects of these changes on the Romanian agri-food market, with a particular focus on price developments. Using a quantitative methodology based on the analysis of data on imports and price fluctuations between the periods 2020-2021 and 2022-2023, the research highlights both the benefits and the challenges generated by these massive imports. The results show that while imports from Ukraine reached a record high in 2022, the impact on prices has been uneven, with prices remaining high despite increased supply. The study emphasizes the importance of support measures for local producers and the need for a balanced strategy to ensure the stability of the Romanian agri-food market.*

**Keywords:** agro-food imports, Ukraine, Romania, Russia-Ukraine conflict, prices, international trade, agriculture, supply chains, agricultural economy.

**JEL Classification:** M40, M41.

## 1. Introduction and context of the study

The armed conflict between Russia and Ukraine, which began in 2022, has had major consequences for regional trade, directly affecting agri-food markets in Eastern Europe. Restrictions on maritime transport in the Black Sea, imposed by the Russian blockade of Ukrainian ports, have forced Ukraine to reconfigure its trade routes for the export of cereals, oilseeds and other essential agri-food products. In this context, Romania has become a strategic point for both the transit of Ukrainian goods and their integration into European supply chains. The Port of Constanta has played a key role in absorbing a significant part of Ukrainian exports, becoming a crucial alternative to maritime transport. Its capacity has been rapidly expanded to handle higher volumes of goods, and Romania's rail and road infrastructure has been adapted to facilitate trade flows. The Danube has also become an important transport artery, allowing the transfer of grain from Ukrainian ports on the river to logistics hubs in the European Union (Voicilas, 2020).

This redirection of trade flows has generated both opportunities and challenges for Romania and other countries in the region. On the one hand, Romanian infrastructure has benefited from investments and modernizations aimed at improving transport logistics. On the other hand, the large influx of Ukrainian products has created tensions among Romanian farmers, who have faced increased competition and a decrease in prices for local products (Olei, 2019).

At the European level, the European Union has intervened by adopting support measures for the states affected by the increase in trade flows, including by financing infrastructure projects and providing compensation for affected farmers. At the same time, solidarity corridors created to facilitate Ukrainian exports have become an essential component of European trade policy in the context of the conflict (Jagtap et al., 2022).

Thus, the impact of the war on the agri-food markets in Eastern Europe was not limited to the reconfiguration of trade routes, but also influenced the economic and political balance in the region. Romania, through its strategic position, became a key actor in managing the global food crisis and in maintaining the stability of agricultural markets in the EU (Veghes and Dima, 2022).

This paper aims to analyze the impact of these massive imports on the agri-food market in Romania, with a particular focus on price developments. The study compares two distinct periods, 2020-2021 and 2022-2023, to highlight the changes caused by the conflict and to provide a clear picture of the economic implications of the new trade routes.

## 2. Literature review

Existing studies on international agri-food trade highlight the importance of supply chains and their stability in maintaining predictable prices (Morales, 2017). The literature indicates that external shocks, such as armed conflicts or trade restrictions, can generate

volatility in agri-food markets, affecting both producers and consumers (Bellemare, 2015; Headey and Fan, 2010).

Research on the impact of the war in Ukraine on European agri-food markets is still developing, but initial analyses suggest that the redirection of Ukrainian exports through neighboring countries has had consequences on prices and the competitiveness of local producers (OECD, 2023). In the case of Romania, the increase in agri-food imports from Ukraine has been accompanied by concerns about the effects on local farmers and possible market distortions (MADR, 2023).

Economic analyses of agri-food markets in crisis contexts highlight that agri-food prices can be influenced by both internal and external factors, such as variations in global supply and demand, trade policies and tariff barriers (Gouel & Jean, 2015). Studies on trade shocks indicate that massive imports can lead to lower prices on the domestic market by increasing supply, but can also generate negative effects on local producers by reducing their competitiveness (Anderson and Nelgen, 2012).

Several studies conducted by FAO (2022) and the World Bank (2022) highlight that the unrestricted access of Ukrainian agri-food products to the markets of neighboring countries has generated economic pressures on local farmers. In particular, Romania, Poland and Hungary have reported difficulties in maintaining the competitiveness of their own agricultural production due to lower prices for Ukrainian products. Reports also show that these rapid changes can have long-lasting effects on the structure of agricultural markets and may require compensatory measures from the state (European Commission, 2024). In conclusion, the specialized literature highlights a series of determining factors for the evolution of agri-food markets in contexts of geopolitical crisis. The present study aims to contribute to this literature through a detailed analysis of how massive imports from Ukraine influenced the prices of agri-food products in Romania, considering the market dynamics and the economic implications of this phenomenon.

### **3. Methodology**

To assess the impact of agri-food imports from Ukraine on the Romanian market, this paper uses a quantitative methodology based on the analysis of import data and price developments. The study is carried out in several stages, each of which plays an essential role in identifying and interpreting the effects of these imports on the Romanian agricultural economy.

**Data collection:** Data on agri-food imports are taken from official sources, such as the National Institute of Statistics (INS), Eurostat and the Ministry of Agriculture. In parallel, data on the average prices of the main agri-food products in Romania are used to analyze the correlations between imported volumes and price fluctuations.

**Analysis period:** The study compares two distinct time intervals – the pre-conflict period (2020-2021) and the post-conflict period (2022-2023). This comparison allows for the

observation of the changes generated by the increase in imports from Ukraine and their impact on the domestic market.

#### *Analysis methods*

Descriptive analysis of the evolution of imports and prices for the main agri-food products.

Statistical analysis using correlation coefficients and econometric regressions to identify the relationships between import volume and price dynamics.

Comparison of trends through diagrams and graphs, highlighting significant changes in the market.

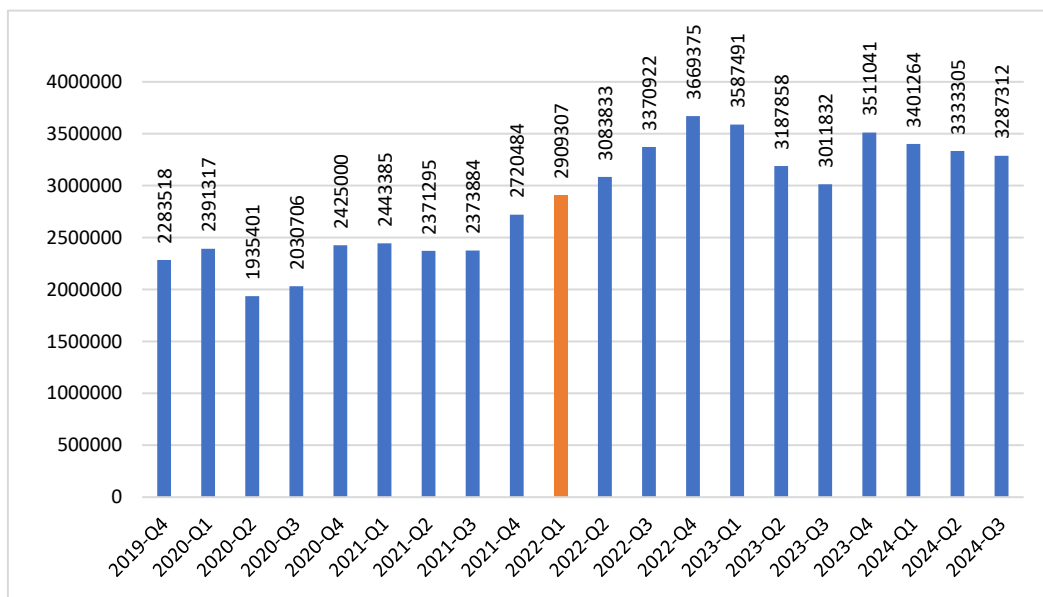
Interpretation of results: Based on the results obtained, conclusions will be drawn regarding the impact of imports from Ukraine on the agri-food market in Romania. The implications for local producers, consumers and policymakers will be highlighted, providing a detailed perspective on the economic and trade changes determined by these changes.

Through this approach, the study will contribute to understanding how geopolitical and trade changes influence Romania's agricultural economy. It will also provide a basis for formulating public policies adapted to the new market realities, thus supporting informed decision-making in the agri-food sector.

## 4. Results and discussion

In the research, we started by studying the dynamics of the value of imports of agri-food products at the level of Romania, in order to determine the first variable analyzed (Figure 1).

**Figure 1.** Value of Romanian food imports, in the period 2020-2023, quarterly





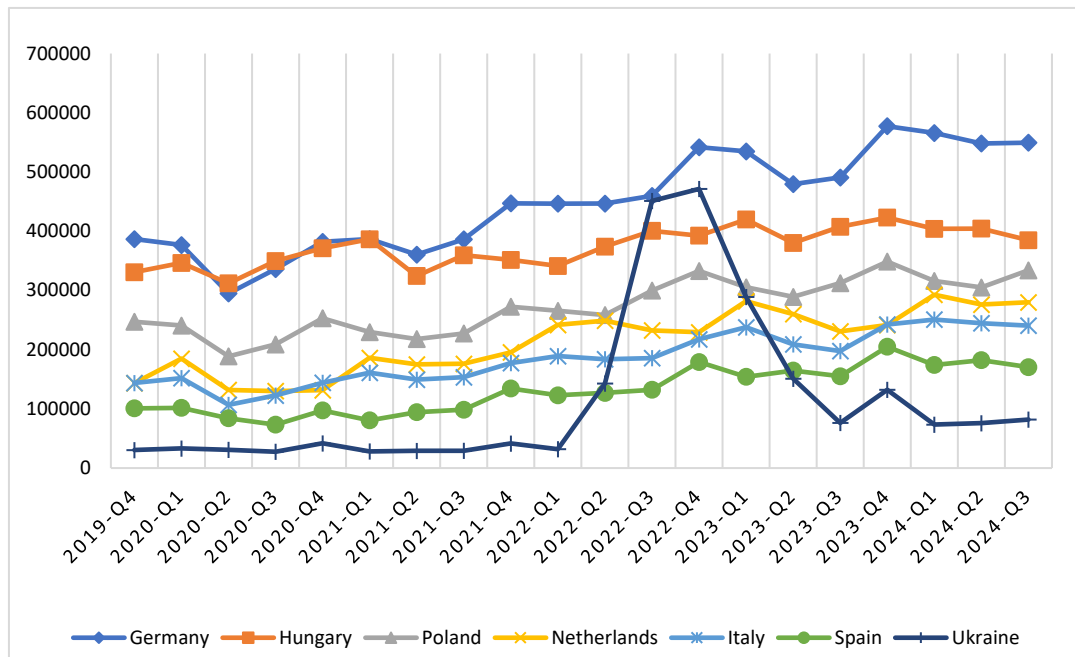
The graph shows the evolution of Romania's total imports of agri-food products from the 4th quarter of 2019 to the 3rd quarter of 2024.

In 2020-Q2, there was a significant decrease, probably as a result of the COVID-19 pandemic. After 2020-Q3, imports began a gradual recovery, maintaining a constant increase throughout 2021.

Starting with 2022-Q1, there was a strong increase, culminating in a peak in 2022-Q4. The year 2023 was characterized by oscillations, with a slight decrease after the first quarter, followed by a strong recovery in 2023-Q4.

For 2024, a slight decrease is observed, but imports remain at a high level compared to previous years.

**Figure 2.** *Dinamics of Romanian food imports value, in the period 2020-2023, quarterly*



The graph shows the evolution of Romania's imports from the top 5 agri-food exporting countries between Q4 2019 and Q3 2024.

Germany is Romania's main supplier, with significant increases after 2022-Q1, reaching a peak in 2023-Q4. However, in 2024, imports from this country register a slight decrease, but remain at a high level.

Hungary shows a stable trend, with moderate variations, but maintaining its importance as a trading partner of Romania. In 2023 and 2024, a moderate increase is noted, indicating a consolidation of trade relations between the two countries.

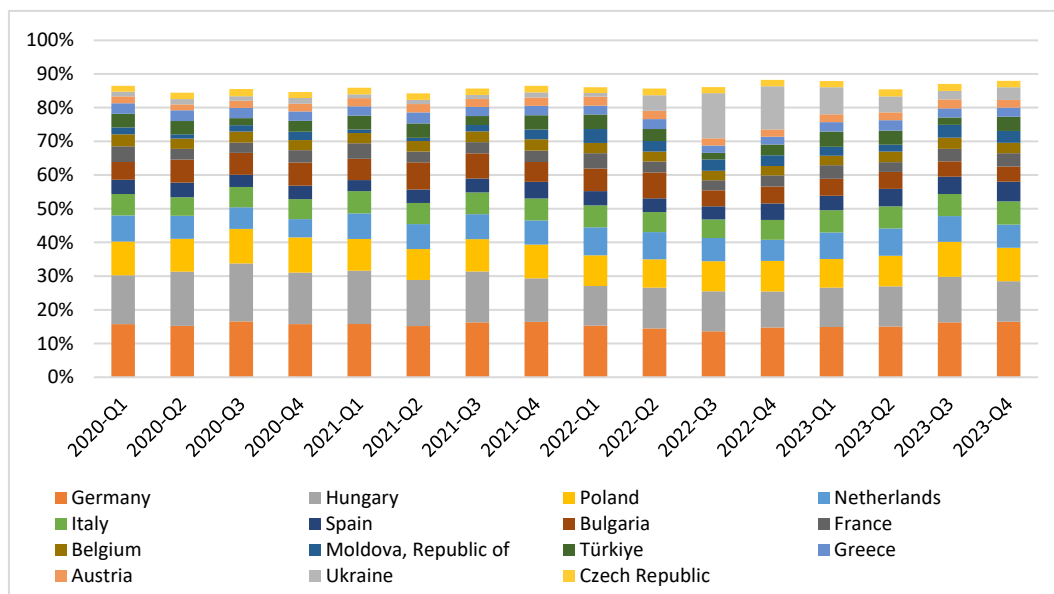
Poland follows an upward trend, although with greater fluctuations compared to other trading partners. Imports from this country have continued to increase in recent years, which shows Romania's increasing dependence on Polish agri-food products.

The Netherlands (Holland) recorded a significant increase in 2022, followed by successive declines and recoveries. These oscillations may be influenced by international economic and logistical conditions, which affect Dutch exports.

Italy maintains a stable level of imports, with small oscillations from year to year. This suggests a consolidated and constant trade relationship, without major changes in the period analyzed.

An important aspect to mention is the situation of Ukraine, which, starting with 2022, has become an increasingly important supplier, despite the effects of the war with Russia. After the outbreak of the conflict, imports from Ukraine recorded spectacular increases, especially in 2022 and 2023, due to changes in supply chains and trade facilities granted by the EU. In 2024, although imports seem to stabilize, Ukraine remains an essential player in the Romanian agri-food market.

**Figure 3.** Share of Romanian food imports value, in the period 2020-2023, quarterly



During the period 2020-2023, the shares of Romania's imports from the main exporting countries underwent significant changes, especially as a result of the conflict between Russia and Ukraine. This evolution can be analyzed in two distinct stages: the pre-conflict period (2020-Q1 – 2021-Q4) and the post-conflict period (2022-Q1 – 2023-Q4).

During the pre-conflict Russia-Ukraine period (2020-Q1 – 2021-Q4), the structure of Romania's imports was relatively stable, without major fluctuations in the shares of each

exporting country. Germany and Hungary dominated imports, with shares of 14%-17%, reflecting a high dependence on these two states. Poland and the Netherlands also played an important role, with shares between 8% and 10%, maintaining a constant contribution to Romania's trade flows.

In the case of other countries such as Italy, Spain, Bulgaria, France, Belgium and Greece, imports ranged between 3% and 6%, without significant changes during the period analyzed. A notable aspect is the presence of Ukraine, which before the conflict had a low influence on Romania's imports, with a share of only 1%-2%. This indicates that Ukraine was not an essential supplier of agri-food products for Romania before 2022.

After the Russian invasion of Ukraine, which began in February 2022, the structure of Romania's imports changed significantly. The most notable change was the exponential increase in imports from Ukraine, which went from 1%-2% before the conflict, to a peak of 13% in 2022-Q3 and Q4. This sudden increase was due to logistical changes and the facilities granted by the European Union to Ukrainian agri-food products.

In 2023-Q1, imports from Ukraine remained high (8%), but later started to decline, reaching 5%-4% in the following quarters. This trend suggests a possible stabilization of the market and an adaptation of Romania to the new trade conditions in the region. At the same time, Germany, Hungary and Poland maintained their influence on imports, with relatively stable shares, with 14%-16% for Germany, 11%-16% for Hungary and 9%-10% for Poland.

Although imports from the Netherlands, Italy, France and Belgium did not undergo significant changes, Austria and other Western European states maintained a low influence, with shares ranging between 2%-3%. This indicates that the changes in Romania's agri-food trade did not significantly affect imports from these countries.

In order to significantly determine the differences in the value of imports in the mentioned periods, respectively before the conflict and the period after, the t-test was used to determine the differences between the means (table 1).

**Table 1.** *t-Test: Value of food import in Romania pre și post conflict*

	GERMANY		HUNGARY		POLAND		NETHERLANDS		ITALY		UKRAINE	
	Variable 1	Variable 2	Variable 1	Variable 2	Variable 1	Variable 2	Variable 1	Variable 2	Variable 1	Variable 2	Variable 1	Variable 2
Mean	371105	496959	349937	392145	229647	301344	163659	245638	145595	207676	32479	217966
Variance	1931232883	2390150929	569730463	724867365	678012807	952214541	772893132	316416947	485627899	529570531	33801829	27981227987
Observations	8	8	8	8	8	8	8	8	8	8	8	8
Hypothesized Mean Difference	0		0		0		0		0		0	
df	14		14		14		12		14		7	
t Stat	-5.4150		-3.3180		-5.0225		-7.0254		-5.5110		-3.1345	
P(T<=t) one-tail	0.0000		0.0025		0.0001		0.0000		0.0000		0.0083	
t Critical one-tail	1.7613		1.7613		1.7613		1.7823		1.7613		1.8946	
P(T<=t) two-tail	0.0001		0.0051		0.0002		0.0000		0.0001		0.0165	
t Critical two-tail	2.1448		2.1448		2.1448		2.1788		2.1448		2.3646	

**Source:** contribution of authors.

Following the t-Test: Two-Sample Assuming Unequal Variances analysis, significant increases in Romania's imports from Germany, Hungary, Poland, the Netherlands, Italy and Ukraine are observed between the pre-conflict period (2020-Q1 – 2021-Q4) and the post-conflict period (2022-Q1 – 2023-Q4). For each country, we also calculated the percentage share of increase in imports between the two periods.

Imports from Germany increased from an average of 371,105 thousand euros in the pre-conflict period to 496,958.5 thousand euros in the post-conflict period. This represents an increase of approximately 33.9%.

The results of the statistical test indicate a significant difference between the means (t Stat = -5.4150, P-value two-tailed = 9.11E-05), which confirms that this increase is not random. This suggests a greater dependence of Romania on German imports in the post-conflict period, probably due to the need for stability in supply chains.

In the case of Hungary, the average imports increased from 349,936.8 thousand euros to 392,144.6 thousand euros, which represents an increase of approximately 12.1%.

The statistical test indicates a significant difference between the two periods (t Stat = -3.3176, P-value two-tailed = 0.005078). This more moderate increase, compared to Germany, suggests that Romania continued to import steadily from Hungary, but without dramatic changes in dependence on this trading partner.

Imports from Poland increased from an average of 229,647.4 thousand euros to 301,344 thousand euros, marking an increase of approximately 31.2%.

The test results (t Stat = -5.0225, P-value two-tailed = 0.000187) show a significant difference between the two periods. This suggests that Poland has consolidated its position as a key supplier for Romania, with a significant increase in trade volumes.

The average imports from the Netherlands increased from 163,658.8 thousand euros to 245,637.9 thousand euros, which means an increase of approximately 50.1%, the highest percentage increase among the European countries analyzed.

The statistical test indicates a very significant difference (t Stat = -7.0254, P-value two-tailed = 1.38E-05), confirming that this increase is not accidental. The Netherlands has become an increasingly important supplier, which suggests an intensification of trade relations between the two countries, possibly due to the reorientation of logistics chains.

Imports from Italy increased from 145,594.5 thousand euros to 207,675.5 thousand euros, registering an increase of approximately 42.6%.

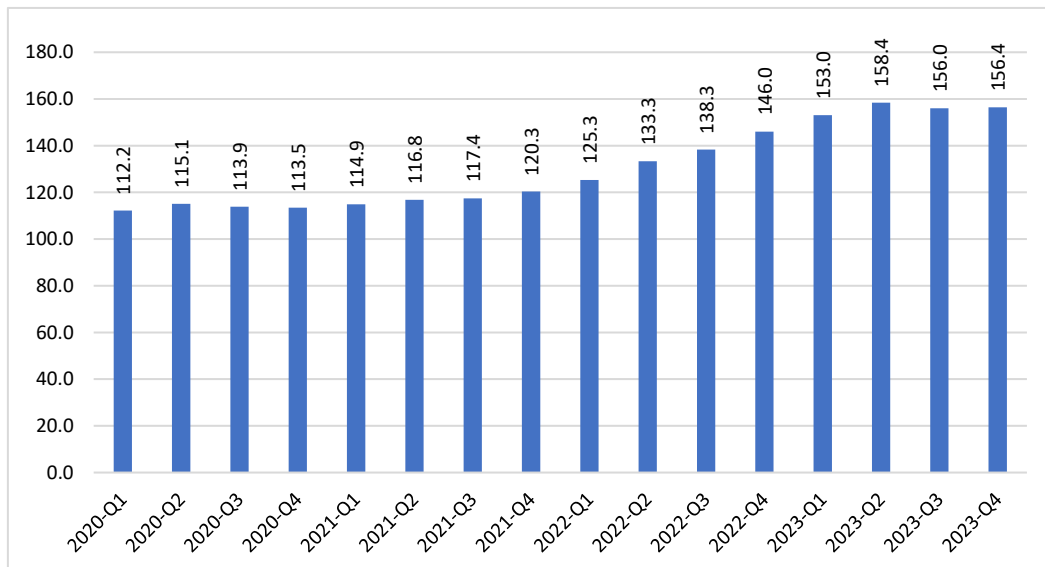
The test results (t Stat = -5.51097, P-value two-tailed = 7.67E-05) show that this increase is significant. Italy has become a more important partner for Romania in the post-conflict period, probably due to changes in supply networks and increased demand for certain agri-food products.

Imports from Ukraine recorded the most spectacular increase, from an average of 32,478.88 thousand euros in the pre-conflict period to 217,965.9 thousand euros in the post-conflict period. This represents an increase of approximately 571.3%, the largest of all the countries analyzed.

The test results (t Stat = -3.13446, P-value two-tailed = 0.016506) confirm that this increase is statistically significant. This massive jump is explained by the support provided by the European Union to Ukraine for agri-food exports, but also by the reorientation of trade flows in the region after the start of the conflict.

Next, a second variable in our analysis was the one related to the dynamics of agri-food product prices (figure 4).

**Figure 4.** Consumer Prices Food Indices (2015 = 100)



The food price index chart shows a significant increase in food prices between 2020-Q1 and 2023-Q4, with a peak in 2023-Q3 and a slight stabilization in 2023-Q4. This index reflects changes in food costs for consumers and is influenced by factors such as imports, domestic supply, inflation and geopolitical events.

In 2020, the food price index was relatively stable, ranging between 112.2 and 115.1, indicating moderate price increases. In 2021, the index continued to increase gradually, reaching 120.3 in Q4, suggesting moderate inflation, driven by the post-pandemic economic recovery.

In 2022, prices rose sharply, with the index rising from 125.3 in Q1 to 146.0 in Q4, an increase of 16.5% over the year. This price explosion coincided with the onset of the Russia-Ukraine conflict, which disrupted supply chains and led to increases in the costs of energy and agricultural raw materials.

In 2023, the index reached record values, fluctuating between 153.0 and 158.4 in the first three quarters, but stabilized slightly at 156.4 in Q4. This indicates a slowdown in price growth, a sign that the market is starting to stabilize, but food prices remain significantly higher compared to previous years.

After the increase in agri-food imports from Ukraine starting in 2022-Q1, we would expect a deflationary effect (i.e. a decrease in prices). However, analysis of the price index shows that although imports increased, prices continued to rise in 2022, suggesting that the price-reducing effect of imports was not sufficient to counteract global inflationary pressures.

In 2023, prices stabilized at a high level, suggesting that the increased availability of Ukrainian agri-food products helped to moderate price increases. The slight decrease in the index in Q4 2023 (from 158.4 to 156.4) could indicate that large imports of cheaper products from Ukraine and the reduction in global inflation have started to have an effect on the market.

In table 2 we identify the Pearson correlation coefficients between the two variables.

**Table 2.** Correlation between variables

		Correlations		
		CPFI	WD_FI	UKR_FI
CPFI	Pearson Correlation	1	,861**	,573*
	Sig. (2-tailed)		,000	,020
	N	16	16	16
WD_FI	Pearson Correlation	,861**	1	,775**
	Sig. (2-tailed)	,000		,000
	N	16	16	16
UKR_FI	Pearson Correlation	,573*	,775**	1
	Sig. (2-tailed)	,020	,000	
	N	16	16	16

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).

The Pearson correlation analysis between the food price index (CPFI), Romania's total agri-food imports (WD\_FI) and Ukraine's agri-food imports (UKR\_FI) reveals significant relationships between these variables. The purpose of this analysis is to identify the impact of imports on food prices and to understand to what extent imports from Ukraine have influenced the Romanian market.

The results show a strong positive correlation ( $r = 0.861$ ) between total imports and food prices. This indicates that as imports increase, food prices also increase.

This relationship is statistically significant ( $p\text{-value} = 0.000$ ), suggesting that Romania is dependent on imports for its agri-food supply, and the increase in imports has not led to a decrease in prices, but to their maintenance at a high level. This phenomenon can be explained by high transportation costs, global inflation and the increase in food demand in the current geopolitical context.

The correlation between imports from Ukraine and food prices is moderate ( $r = 0.573$ ), meaning that although there is a relationship, it is not as strong as in the case of total imports.

The statistical significance of this correlation ( $p\text{-value} = 0.020$ ) confirms that imports from Ukraine had an impact on prices, but not enough to cause a significant reduction in them. This may be due to logistics costs, currency fluctuations or infrastructure limitations that prevented a faster decrease in prices.

We observe a strong correlation ( $r = 0.775$ ) between total imports and imports from Ukraine, indicating that Ukraine has become a crucial supplier for Romania.

This result is statistically significant ( $p\text{-value} = 0.000$ ) and suggests that, in recent years, imports from Ukraine have represented an important part of Romania's total imports. This trend can be explained by the removal of customs duties on Ukrainian agri-food products and the increase in trade flows due to the Russia-Ukraine conflict.

The results show that total imports had a stronger effect on prices than imports from Ukraine, suggesting that Romania relied on more external sources for supplies, not just Ukraine.

For consumers, this phenomenon means that food prices have remained high, even though imports have increased. This is contrary to expectations, as, in theory, an increase in imports should lead to a reduction in prices through competition.

For Romanian farmers, the increasing dependence on imports, especially from Ukraine, may put pressure on domestic production, causing lower purchase prices for producers. This could lead, in the long run, to reduced domestic production and increased dependence on agri-food imports.

If imports from Ukraine continue to increase, food prices are likely to stabilize or even fall slightly. However, if Romanian farmers reduce their production due to competition, domestic supply could decrease, which could lead to price increases in the long term.

Another important factor is the evolution of energy costs and global inflation, which will influence both production costs and final prices of agri-food products.

The massive increase in agri-food imports from Ukraine to Romania, following the conflict with Russia, may have multiple economic and social implications on the Romanian market, especially on local production, the competitiveness of Romanian farmers and the evolution of food prices.

## **5. Conclusions**

The war in Ukraine has led to an accelerated increase in imports from this country, amid logistical changes and facilities granted by the EU. Imports from Ukraine reached a historic high in 2022 (13%), but in 2023 a decrease and stabilization at lower values (5%-4%) was observed.

At the same time, traditional exporting countries, such as Germany, Hungary and Poland, were not significantly affected, maintaining their constant shares in the structure of Romania's imports. This dynamic suggests that Romania and the European Union have managed to integrate Ukrainian agri-food products into a sustainable supply system, but with a slight return to the traditional structure of imports in 2023.

If current trends continue, it is possible that Ukraine will maintain an important presence in Romania's agri-food trade, but without surpassing the influence of traditional partners in the European Union.

All six countries analyzed have recorded significant increases in imports in the post-conflict period. The largest percentage increases were observed for the Netherlands (+50.1%) and Italy (+42.6%), while Poland and Germany had solid increases of over 30%. Imports from Ukraine increased by more than 6 times (+571.3%), indicating a major reorientation of supply chains. Very low p-values ( $< 0.05$ ) for all countries confirm that these increases are statistically significant, meaning that they are not random fluctuations, but reflect a real change in trade flows.

In conclusion, Romania adapted its import strategy following the conflict, significantly increasing its dependence on Ukraine, but also strengthening trade relations with traditional partners in the European Union.

Large imports from Ukraine did not lead to an immediate drop in prices, but helped stabilize them in 2023. In 2024, we may see a slight decrease in prices, but this evolution will depend on the dynamics of the domestic market, imports and macroeconomic factors.

The Pearson correlation analysis shows that total agri-food imports are strongly correlated with the increase in food prices, and imports from Ukraine had a moderate effect on this phenomenon.

These data suggest that although imports increased, they did not lead to a significant decrease in prices, but contributed to stabilizing them at a high level.

The explosion of agri-food imports from Ukraine has caused a significant change in the Romanian market. In the short term, this phenomenon may lead to a decrease in food prices, benefiting processors and consumers. However, in the long term, the negative impact on Romanian farmers may become a major problem, reducing competitiveness and domestic production, which could generate price fluctuations and increased dependence on foreign imports.

To avoid negative effects in the long term, protective measures for local producers are needed, such as higher subsidies, import regulations and stimulating the consumption of domestic products. This situation represents a major challenge for Romanian agriculture and requires a balanced strategy to maintain the stability of the agri-food market.



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## An empirical analysis of foreign trade concentration between Türkiye and Egypt (2005-2023)

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**Abstract.** *This study aims to analyze the development of foreign trade between Türkiye and Egypt for the period 2005-2023, following the implementation of their free trade agreement. For this purpose, the concentration levels of foreign trade between those countries were evaluated through the calculation of the Export Concentration Index, and the Import Concentration Index. The findings of the study indicate that, despite the tensions following the 2011 Arab Spring, the foreign trade relationship between Türkiye and Egypt has shown a consistent and substantial improvement. The clearest evidence showed concentration indices for both countries' exports and imports have significantly surpassed 1 ( $\geq 1$ ).*

**Keywords:** Türkiye, Egypt, Foreign Trade, Trade Concentration Indexes, Bilateral Relations.

**JEL Classification:** F10, F14, F50.

## 1. Introduction

Foreign trade is widely acknowledged to play a critical role in all economies, serving as a driving factor for each country's economic growth and development processes. It is an essential tool for achieving comprehensive development of the state (Bouaisha and Marsili, 2022: p.1). The balance of payments is considered one of the most important macroeconomic indicators and a tool for assessing the performance of the national economies. Thus, it reflects the state and position of the national economy and reveals its strengths and weaknesses. It also demonstrates its current state and position, the extent of its reliance on the outside world, the amount of external debt, and the nature of its economic relations with other nations. Foreign trade is the most significant element influencing the trade balance. Hence, the influence and link between foreign trade and trade balance become apparent (Sulaiman, 2021: pp.31-32). Foreign trade facilitates interaction and exchange between the domestic and global markets.

Real exchange rates, gross domestic product (GDP), relative prices, and other economic variables are fundamental foreign trade indicators. However, it must be accepted that economic factors and political relations between the countries greatly influence their bilateral foreign trade. These domains have grown inseparably linked with economic tools, becoming central in global political strategy. This integration gave rise to theories like International Political Economy (IPE), blending economic and political perspectives on global interactions. IPE debates are primarily framed by Liberal and Realist theories, each offering divergent perspectives on the role of foreign trade in international relations: Liberals posit that foreign trade is essential for maximizing social welfare, with political stability and globalization facilitating robust trade. They argue that trade relations enhance political ties, as nations prioritize economic benefits over conflict (Çakmak & Ustaoglu, 2017). This viewpoint aligns with the "democratic peace theory," asserting that democracies, bound by economic interdependence, are less likely to engage in conflict. In contrast, Realists view states as power-maximizing entities, considering foreign trade as a means to strengthen national security. Realists say trade relations are temporary and driven by strategic interests, with political decisions dictating economic interactions (Öncel and Liapina, 2018).

Studies exploring the interplay between political dynamics and trade reveal varying conclusions: Keshk et al. (2004) confirmed that political conflicts constrain trade but found mixed evidence on the pacifying effect of trade interdependence. Armstrong (2012) analyzed Japan-China trade under political strain, observing limited effects of political tensions on trade. Davis et al. (2015) showed that worsening political relations significantly decreased trade, particularly in state-controlled sectors. Rasoulinezhad (2016) illustrated how sanctions and oil price fluctuations negatively impacted Iran-Russia trade. Çakmak and Ustaoglu (2017) identified a strong correlation between diplomatic relations and bilateral trade in Turkey-Israel foreign trade relations and stated that critical political crises led to sharp trade declines. The relationship between trade and political relations is

bidirectional. While trade can foster diplomatic ties, political decisions significantly influence trade dynamics. In a similar study on Türkiye-Russia foreign trade, Öncel and Liapina (2018) concluded that trade relations are negatively affected if political relations deteriorate. Theoretical and empirical studies underline the complexity of this interplay, with outcomes varying based on political regimes, economic strategies, and geopolitical contexts. Further research, integrating political relations into traditional trade models is essential to understanding this multifaceted relationship.

Türkiye and Egypt have mutual economic, cultural, political, historical, and social relationships. Although political relations between the two countries have experienced tension, their economic interactions have remained resilient mainly because of differences in their foreign policy objectives. Both countries continue to prioritize and strengthen bilateral trade, recognizing that while governments shape political dynamics, foreign trade is driven by individual actors. Türkiye and Egypt are regarded as the two most important countries in the eastern Mediterranean region and are two substantial military powers and two important Islamic centers (Abu Al-Ela, 2023: pp.727-731). One of the most important economic aspects of Egyptian-Turkish relations in the twenty-first century is the 2005 free trade agreement, which went into effect in 2007, despite tensions in political relations between the two parties following the Arab Spring revolutions of 2011, and particularly after the fall of the Muslim Brotherhood Party in Egypt following which each country recalls its ambassador from the other. However, this economic agreement remained free of disintegration and political tension. The level of commercial exchange between the two parties (in products and services) has expanded over time, with more than 7 billion USD exchanged between the two nations in 2022 (CAPMAS, 2024). Now that diplomatic relations have mended, and President Recep Tayyip Erdoğan has met his Egyptian counterpart, Leader Abdel Fattah el-Sisi, following an 11-year rupture, trade relations between the two countries are likely to grow and expand. This study aims to analyze Turkish-Egyptian trade relations following the 2005 free trade agreement through the period of political tension that began to emerge after the events of the January 2011 revolution and escalated further after the Muslim Brotherhood was ousted by presidential rule.

In this study, trade relations between Türkiye and Egypt for 2005-2023 were analyzed within the framework of foreign trade data such as exports, imports, and total trade volume. To this end, the Export Concentration Index and Import Concentration Index were calculated to determine the intensity of trade relations between the two countries. This approach allows for an assessment of the share of trade between Türkiye and Egypt in total foreign trade. Furthermore, in the subsequent section of the study, changes in the sectors involved in trade, both in terms of goods and services, over the years were analyzed. The study also explores which specific goods trade relations between the two countries are the most dependent.

The rest of the study is structured as follows: The second section reviews the relevant empirical literature. The third section focuses on analyzing the economic relations between the two countries, including evaluating trade exchanges (exports and imports) and calculating trade concentration indicators for both Türkiye and Egypt. Finally, suggestions are proposed to boost the potential trade between Türkiye and Egypt.

## 2. Literature Review

All nations strive to enhance their global commercial relationships and seek membership in regional and international blocs and unions. This is primarily because countries recognize the critical role these relationships play in strengthening their international standing, expanding their influence, and fostering foreign trade. Foreign trade, in particular, serves as the cornerstone of economic development in every nation. A country's focus on foreign trade has numerous advantages, including increased production, growth in GDP through higher export and import volumes, and revenue generation that stimulates investment and fosters positive economic activity (Bouaisha and Marsili, 2022: p.9). The importance of foreign trade can be categorized into three intellectual perspectives: mercantilist, classical, and modern. Mercantilists argue that precious metals are the primary sources of a state's wealth. Consequently, they emphasize the significance of foreign trade as one of the most effective means of wealth generation, primarily through the expansion of exports and the regulation or restriction of imports (Khobai et al., 2018: p.78). From the classical perspective, as articulated by Adam Smith, labor and production constitute the fundamental sources of a nation's wealth. Foreign trade is essential because it supports the growth of the productive and industrial sectors. It generates economic benefits when a country specializes in producing and exporting goods for which it has an absolute cost advantage compared to other nations. In contrast, modern theories, particularly Linder's theory, view foreign trade as an extension of the domestic market, facilitating the disposal of surplus production. According to this perspective, the greater the external demand for a country's products, the higher are the gains from foreign trade. This, in turn, promotes greater production and efficiency within the economy (Alsheikh and Balangari, 2021: pp.55-56).

Empirical research on the development of trade and trade concentration involving Türkiye and Egypt remains relatively scarce. One study examining Türkiye's trade dynamics, conducted by Kurt Gümüş and Kramskova (2024), revealed that Türkiye and Russia function more as trade partners than their international competitors. Using trade indicators such as trade intensity and trade integration, this study identifies robust bilateral trade flows between the two countries from 2001 to 2021. Despite global crises and various political and economic challenges, Russia managed to increase its exports to Türkiye, although Türkiye did not reciprocate to the same extent. Teker et al. (2022) investigated the effects of the COVID-19 pandemic and Russian-Ukrainian war on global supply chains and found that trade between Türkiye and China remained unaffected and continued to grow steadily.

However, this growth was largely driven by an increase in Chinese exports to Türkiye, which resulted in a widening trade gap between the two nations. Similarly, Selçuki and Tulan (2021) highlight the influence of political relations between Türkiye and the European Union on economic ties. They noted that stronger political relations led to deeper economic integration, identifying industries and products with significant trade advantages through trade indicators and Revealed Comparative Advantage (RCA) analysis. Alpdoğan et al. (2020) analyzed trade relations between Türkiye and Azerbaijan for the period 1995–2015, emphasizing the importance of bilateral commercial exchange through foreign trade statistics and concentration indicators. Öncel and Liapina (2018) explored the impact of political relations on the Turkish-Russian trade balance. Their findings indicated that deteriorating political relations negatively affected trade during the study period. However, the study also concluded that Russia's GDP growth positively influenced bilateral trade between 1996 and 2016, using least squares regression and the Augmented Dickey-Fuller (ADF) test. Regarding Egypt's foreign trade concentration, Reda et al. (2012) found that Egypt's trade intensity index with China was relatively low, suggesting that trade between the two countries was below potential. This conclusion was based on the analysis of trade intensity, intra-industry trade indices, and trade complementarity measures during the period 1994–2008.

The literature review revealed a lack of studies calculating the trade concentration between Türkiye and Egypt. However, Allam (2017) conducted research on trade relations between the two countries and found that 72% of Egyptian enterprises import goods from Türkiye, but do not export goods. Conversely, 10% of Turkish enterprises import goods from Egypt but do not export them, while 65% of Turkish enterprises in the study's sample export to Egypt but do not engage in imports. This study identified several obstacles affecting the volume of trade exchanges between the two nations, including political disputes, administrative barriers, and custom-related challenges. These findings were derived from a survey administered to Turkish and Egyptian companies. In addition, Saad (2024) explored the Egyptian-Turkish relationship from a political perspective and analyzed the impact of the ideological orientations of political leaders in both countries. The study examined how these ideologies shaped bilateral relations and highlighted changes in these dynamics over the period 2013–2024. Our study seeks to address the research gap in Turkish-Egyptian trade relations by analyzing bilateral trade ties and investigating the concentration of trade exchanges.

### 3. The Economic Relations between Türkiye and Egypt Review

Economic and trade relations between Egypt and Türkiye have deep historical roots that predated the Ottoman Empire. These relations are characterized by a long-standing interdependence founded on a rich heritage of shared history, culture, and cooperation. Historical records trace the origins of these relations to the oldest known treaty in human history, "the Treaty of Kadesh," which was established between the Hittite kingdom in

Anatolia and the ancient Egyptian state (between King Khatushili III and King Ramesses II), following the Battle of Kadesh in 1274 BC (Al-Othmani, 2023). The treaty's text, inscribed on a stone tablet, is currently preserved in the Istanbul Museum, while another copy of the hieroglyphics is located in Luxor, Egypt. Throughout the Ottoman era, Egypt held a significant position within the Ottoman High House, and Ottoman monuments continued to maintain their prestige and importance in Egypt. This shared heritage has fostered strong ties between the two nations, resulting in a robust friendship that remains resilient despite fluctuations in diplomatic relations or differences in political leadership and foreign policy. This bilateral cooperation and interdependence are particularly evident in contemporary economic relations, as the two countries engage in significant mutual investments and have been bound by a free trade agreement for nearly two decades (USAID, 2007). The most salient aspects of the current bilateral economic relations between Türkiye and Egypt are: The free trade agreement and its resultant trade benefits for both nations and the Turkish industrial zone for vehicles and machinery.

Among the investments between the two countries are ongoing negotiations to establish a Turkish industrial zone within Egypt, specializing in automobiles, machinery, and equipment, analogous to the existing industrial zone in the city of Bursa, which specializes in textiles, automobiles, aluminium, machinery, equipment, and advanced technologies. This region is intended to serve as an export hub from Egypt to the markets of Europe (Economy Plus, 2024), the United States of America, the Arabian Gulf, and North Africa, particularly given Egypt's free trade agreements with these markets that facilitate expedited access for Turkish products. Furthermore, this region will be attractive to various Turkish investors by facilitating investment in the Egyptian market.

A bilateral free trade agreement was signed in 2005 (WIPO, 2005), which came into effect in 2007 to establish a free trade area between the two countries over a period not exceeding twelve years from the date of ratification. According to this agreement, Egyptian industrial exports to Türkiye are immediately exempted from customs duties and other fees and taxes with similar effects, in addition to applying discount rates to a specific list of products that vary over time until they reach full exemption. The free trade agreement not only provides Egyptian industrial exports with full and immediate access to the large Turkish market, but also facilitates access to the European Union market (Mohammed, 2012: pp.3-4) by integrating Turkish and Egyptian industries and enabling Egyptian exporters to benefit from Türkiye's experience in the European Union. Consequently, the Free Trade Agreement achieves several trade benefits, the most significant of which are removing restrictions imposed on trade in goods, including agricultural products, creating a suitable environment to attract more investments, ensuring fair trade competition between the two countries, and facilitating access to European Union markets. Egypt-Africa free trade agreements such as the Common Market for Eastern and Southern Africa (COMESA) Agreement facilitate access for Turkish investors.



### 3.1. Trade exchange between Türkiye and Egypt (2005-2023)

Egypt is currently recognized as Türkiye's primary trading partner on the African continent. Both nations provide substantial markets for each other's exports (Fouad, 2024). Despite the interruption in diplomatic relations, economic ties remained mutually beneficial and played a significant role in the restoration of official relations between the two countries. Since the two parties agreed to the free trade agreement, intra-regional trade and commercial exchange rates between them have expanded, with bilateral trade rates between the two parties. Investments also increased as the volume of Turkish investments operating in the Egyptian market currently amounts to 77.8 million USD, while the value of projects implemented by Turkish contractors in Egypt is approximately 1.2 billion USD, according to data from the Central Agency for Public Mobilization and Statistics in Egypt (TurkPress, 2024).

Foreign trade between Egypt and Türkiye is considered a crucial element in economic relations between the two countries. Foreign trade between them has grown substantially in recent years. The free trade agreement signed in 2005 played an essential role in boosting the volume of trade exchange between the two countries, increasing their exports to each other and enhancing their reliance on each other for capital and consumer goods imports. As can be seen from Table 1, Turkish exports to Egypt have increased significantly since 2005, rising from 687,299 thousand USD in 2005 to 3,336,392 thousand USD in 2013, reaching a peak of 4,557,744 thousand USD in 2022. Moreover, Turkish imports from Egypt gradually increased starting from 267,246 in 2005, reaching 1,718,720 thousand USD in 2013, and attaining their highest value of 3,644,927 thousand USD in 2023.

**Table 1.** *Turkish-Egyptian foreign trade volumes (2005-2023)*

Years	The volume of Türkiye's exports to Egypt			The volume of Türkiye's imports from Egypt		
	Volume (thousand USD)	Türkiye's total export volume	Share in the Total Exports of Türkiye (%)	Volume (thousand USD)	Türkiye's total import volume	Share in the Total Imports of Türkiye (%)
2005	687,299	73,476,408	0.935	267,246	116,770,590	0.229
2006	709,353	85,534,462	0.829	392,524	139,571,710	0.281
2007	902,703	107,271,750	0.842	652,988	170,062,715	0.384
2008	1,426,450	132,027,196	1.080	886,237	201,963,574	0.439
2009	2,599,030	102,142,613	2.545	641,552	140,928,421	0.455
2010	2,250,577	113,883,219	1.976	926,476	185,544,332	0.499
2011	2,759,311	134,906,869	2.045	1,382,216	240,841,676	0.574
2012	3,679,195	152,461,737	2.413	1,342,051	236,545,141	0.567
2013	3,336,392	161,480,915	2.066	1,718,720	260,822,803	0.659
2014	3,442,287	166,504,862	2.067	1,535,280	251,142,429	0.611
2015	3,124,968	143,844,066	2.172	1,215,905	207,235,628	0.587
2016	2,733,143	142,606,247	1.917	1,443,408	198,601,934	0.727
2017	2,360,734	156,992,940	1.504	1,997,503	233,799,651	0.854
2018	3,053,571	167,923,862	1.818	2,190,937	223,046,879	0.982
2019	3,510,629	180,870,841	1.941	1,903,805	210,346,890	0.905
2020	3,136,568	169,657,940	1.849	1,722,944	219,514,373	0.785
2021	4,519,351	225,264,314	2.006	2,211,676	271,422,758	0.815
2022	4,557,744	254,171,899	1.793	2,550,883	363,710,987	0.701
2023	3,337,302	255,777,398	1.305	3,644,927	361,763,873	1.008

**Source:** Constructed based on International Trade Centre (ITC)

Despite Egypt's relevance to Türkiye as an economic partner and an important global player, the volume of foreign trade remains low. Turkish exports and imports to Egypt accounted for approximately 1.305 and 1.008 percent of the total Turkish exports and imports to the world (figures, respectively). However, with recent improvements in diplomatic relations, trade exchanges and agreements between countries have been projected to increase. Table 2 and Figure 1 indicate the foreign trade volume between Türkiye and Egypt from 2005 to 2023. In 2005, the volume of foreign trade between the two countries was approximately 954,545 thousand USD, which has increased significantly. Despite the highest levels of diplomatic tension in 2013, the trade volume remained consistent, reaching approximately 5,055,112 thousand USD (compared to 2005 and 2006, when political relations were more favourable). The volume of foreign trade between the two countries reached its peak in 2022 at approximately 7,108,627 thousand USD, compared to 6,982,229 thousand USD in 2023. This decline may be attributed to the devastating Hatay earthquake that occurred at the beginning of 2023, which Türkiye continues to address.

**Table 2.** *The volume of foreign trade between Türkiye and Egypt in the period between 2005-2023 (values in thousand USD)*

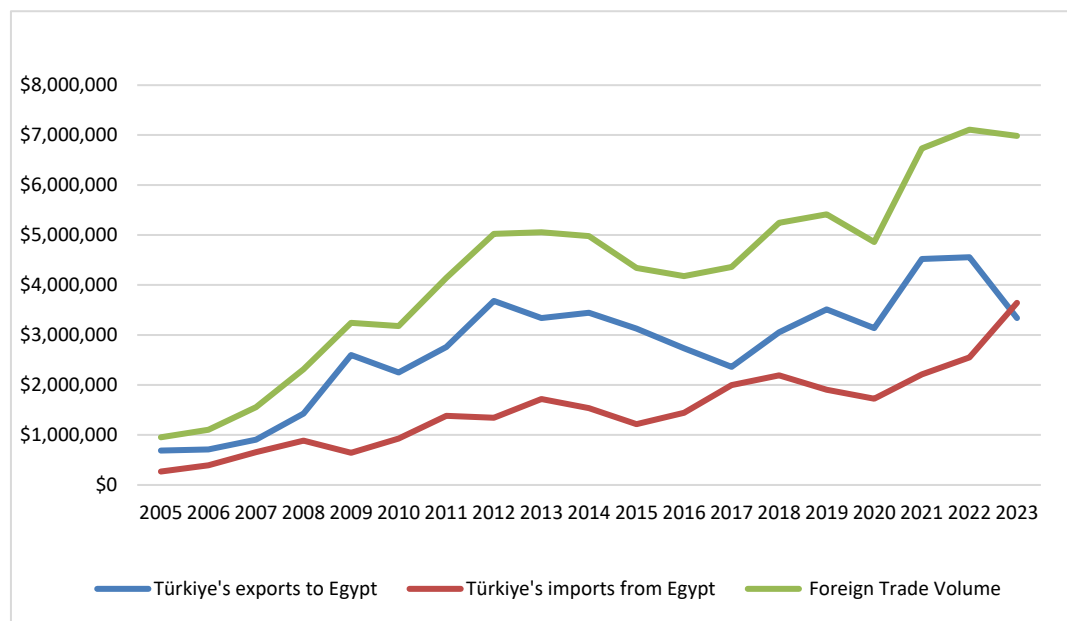
Years	Türkiye's exports to Egypt	Türkiye's imports from Egypt	Foreign Trade Volume
2005	687,299	267,246	954,545
2006	709,353	392,524	1,101,877
2007	902,703	652,988	1,555,691
2008	1,426,450	886,237	2,312,687
2009	2,599,030	641,552	3,240,582
2010	2,250,577	926,476	3,177,053
2011	2,759,311	1,382,216	4,141,527
2012	3,679,195	1,342,051	5,021,246
2013	3,336,392	1,718,720	5,055,112
2014	3,442,287	1,535,280	4,977,567
2015	3,124,968	1,215,905	4,340,873
2016	2,733,143	1,443,408	4,176,551
2017	2,360,734	1,997,503	4,358,237
2018	3,053,571	2,190,937	5,244,508
2019	3,510,629	1,903,805	5,414,434
2020	3,136,568	1,722,944	4,859,512
2021	4,519,351	2,211,676	6,731,027
2022	4,557,744	2,550,883	7,108,627
2023	3,337,302	3,644,927	6,982,229

**Source:** Constructed based on ITC.

The Figure 1 indicates that the volume of foreign trade between the two countries has remained consistently high and stable to date, with the exception of the period 2014-2016 when both nations experienced severe global and internal economic crises. On a global scale, numerous events transpired, with perhaps the most significant being the continuation of the European financial crisis, which impacted supply chains and trade (Hawa, 2013: pp.206-207), and the oil price collapse crisis of 2015-2016 (Zaidi, 2016: p.219), which dealt with a devastating blow to Middle Eastern economies, affecting both oil-producing and non-oil-producing countries. Türkiye and Egypt have experienced negative economic

impacts on bilateral trade. Domestically, Türkiye experienced tension and political instability resulting from parliamentary elections and the failure of parties to form a coalition government (Jurgens, 2021). The Turkish economy was adversely affected, with the value of the Turkish lira depreciating to 2.24 liras to the dollar at the beginning of 2015, continuing to decline until it reached 2.73 liras to the dollar by mid-year. In 2016, political movements advocating for a coup against President Recep Tayyip Erdogan's administration intensified, and Türkiye's economy was affected by these events, as the volume of its foreign trade with the world decreased and macroeconomic indicators declined. These events have influenced the global volume of foreign trade (Al-Sawy, 2015). Conversely, Egypt recorded its highest economic growth rate (4.2) in 2015 over the five years following the Egyptian Revolution of 2011. The GDP growth rate (2014/2015) reached 4.2%, up from 2.2% in (2013/2014) (Easterman, 2015), and several macroeconomic indicators improved as the Egyptian economy began to recover from the effects of the 2011 revolution.

**Figure 1.** The volume of foreign trade between Türkiye and Egypt in the period between 2005-2023



**Source:** The Figure was prepared by the authors using Table 2.

### 3.2. Concentration of foreign trade between Türkiye and Egypt

The ratio of exports to imports (X/M) and the balance of foreign trade (X-M) are two of the most significant indicators that provide information about a country's economic structure. The balance of foreign trade indicates the direction and intensity of a country's influence on foreign trade, whereas the concentration of exports and imports expresses the strength and intensity of bilateral trade (Alpdoğan et al., 2020: p.19). In this context, in

order to measure the concentration level of trade between Türkiye and Egypt, export and import concentration indexes will be calculated for both countries in the following section.

Trade concentration refers to the degree of concentration in trade exchanges between two countries relative to each country's volume of trade exchange with the rest of the world. For instance, if Türkiye's average exports to Egypt exceed the average exports of other countries, this indicates that Türkiye's exports to Egypt are of significant importance and high intensity. Conversely, if Türkiye's average exports to Egypt are lower than the average exports of other countries to Egypt, this suggests that Türkiye's exports to Egypt are of lesser importance and intensity than those of other countries. The conclusion in this case is that trade relations between these two countries are not as intense as previously assumed. This is the primary objective of the study: "Measuring the concentration of trade between Egypt and Türkiye".

The function of this indicator is to elucidate the level and volume of a country's foreign trade with a specific country or group of countries in comparison to the global average. The value of the trade concentration indicators ranges from 0 to  $+\infty$ . An index value greater than "one" indicates that trade relations are "intensive". The export concentration index and import concentration index between Türkiye and Egypt can be calculated with the equations below.

▪ **Export concentration index: equation (1)**

$$EXI_{AB} = \frac{(X_{AB}/X_A)}{M_B/(M_W - M_A)}$$

Interpretation of equation (1):

$X_{AB}$  = Country A's exports to Country B

$X_A$  = Country A's total Exports

$M_B$  = Country B's total imports

$M_W$  = World Imports

$M_A$  = Country's A total imports

▪ **Import concentration index: equation (2)**

$$IMI_{AB} = \frac{M_{AB}/M_A}{X_B/(X_W - X_A)}$$

Interpretation of equation (2):

$M_{AB}$  = Country A's imports from Country B

$M_A$  = Country A's total Imports

$X_B$  = Country B's total exports

$X_W$  = World Exports

$X_A$  = Country's A total exports

In Tables 3 and 4, utilizing data obtained from ITC, and the Turkish Statistical Institute (TURKSTAT) using Equations 1 and 2, the export concentration indices were calculated.

**Table 3.** *Export concentration, and Import concentration of Türkiye's trade to Egypt*

Years	TUR. Export Concentration Index	TUR. Import Concentration Index
2005	4.964	2.210
2006	4.892	2.437
2007	4.353	3.254
2008	3.268	2.647
2009	7.031	2.310
2010	5.648	2.841
2011	5.951	3.271
2012	6.312	3.518
2013	5.760	4.279
2014	5.409	4.261
2015	4.805	4.368
2016	4.307	4.993
2017	3.956	5.626
2018	4.316	6.423
2019	4.791	5.513
2020	4.595	4.643
2021	4.989	4.095
2022	4.669	3.292
2023	3.639	5.519

**Source:** The table was prepared by the authors.

The results in Table 3 demonstrate that Türkiye's export concentration index has exceeded one ( $> 1$ ) since 2005 and continued to increase until it reached its peak value of 7.031 in 2009, indicating that exports between Türkiye and Egypt are intensive and persistent. Similarly, Table 4 reveals that Egypt's export concentration index also exceeded one ( $> 1$ ), reaching a maximum value of 6.009 during the study period in 2018. A comparison of the indicator values for Türkiye and Egypt shows that Türkiye export concentration index values are higher than those of Egypt, suggesting that Egypt is a significant trading partner for Türkiye.

Table 4 presents the values of two concentration indicators (exports and imports) for Egypt and Türkiye during the period 2005-2023. From the values of these two indicators, it can be concluded that both index values exceeded 1 ( $>1$ ), indicating the intensity of Egypt's trade with Türkiye. Upon comparing the values of the import concentration index between Egypt and Türkiye, it is observed that the values of import concentration for Egypt are higher than those for Türkiye, suggesting that Türkiye is a significant partner and an important exporter for Egypt.

**Table 4.** *Export concentration, and Import concentration of Egypt's trade to Türkiye*

Years	EGY. Export Concentration Index	EGY. Import Concentration Index
2005	2.854	4.423
2006	2.324	2.652
2007	2.263	2.177
2008	2.415	2.666
2009	2.624	6.269
2010	3.081	4.693
2011	3.678	5.686
2012	4.161	6.017
2013	4.369	4.592

Years	EGY. Export Concentration Index	EGY. Import Concentration Index
2014	4.060	4.525
2015	4.609	5.068
2016	5.034	5.230
2017	5.545	3.507
2018	6.009	4.648
2019	5.183	4.852
2020	4.685	4.680
2021	5.647	4.121
2022	5.288	3.850
2023	5.815	3.041

**Source:** The table was prepared by the Author.

### 3.3. The main products in Türkiye Exports to Egypt

The structure of Turkish exports is characterized by diversity and comprehensiveness. The Turkish economy possesses abundant resources that enable it to expand its production and export structure. Türkiye exports a wide variety of industrial and food commodities. Türkiye has an extensive export sector that provides multiple channels and markets that are receptive to its products. Furthermore, Turkish exports are distinguished by their high quality and adherence to the standard specifications for various commodities and products.

As indicated in Table 5, Türkiye's list of exports for 2023 is led by several items, including exports of vehicles and railways (and their supplies) valued at 30,837,047 thousand USD of which Egypt's share was approximately 106,555 thousand USD. This was followed by the exports of Nuclear reactors and mechanical appliances worth 25,226,968 thousand USD, of which 424,809 thousand USD were exported to Egypt. Egypt has long been considered a receptive market for various Turkish products, such as Turkish furniture, which has a high reputation in Egypt, as well as Turkish textiles and clothing, in addition to foods and nuts, for which Türkiye is renowned and widely available. Cotton and chemicals are Türkiye's major exports to Egypt in 2023, accounting for 7.3% and 4.8%, respectively, of the total value of Turkish exports worldwide.

**Table 5.** *The Most Important Turkish Exports in 2023 (thousand USD)*

Main Products	Total Exports	Exports to Egypt	Egypt's share
Vehicles other than railway and rolling stock, and parts and accessories thereof	30,837,047	106,555	0.345%
Nuclear reactors, boilers, machinery and mechanical appliances: parts thereof	25,226,968	424,809	1.6%
Iron and steel (Articles of iron or steel)	18,926,268	589,010	3.1%
Articles of apparel and clothing accessories, knitted or crocheted (+not knitted or crocheted)	18,321,785	68,880	0.37%
Mineral fuels, mineral oils and products of their distillation	16,409,266	123,133	0.75%
Electrical machinery and equipment reproducers, television	15,350,853	156,418	1.01%
Plastics and articles thereof	10,590,247	190,873	1.8%
Rubber and articles thereof	3,819,450	91,116	2.38%
Edible fruit and nuts: peel of citrus fruit or melons	5,369,660	27,508	0.5%
Inorganic chemicals; organic or inorganic compounds of precious metals	2,965,959	143,940	4.8%
Cotton	2,100,981	153,848	7.3%

**Source:** ITC, 2024.

### 3.4. The main products of Türkiye's imports from Egypt

Türkiye is considered a significant and prominent importer of energy sources, as imports of fuel and energy sources constitute more than 20% of the total Turkish imports. Türkiye is a net energy importer, with oil imports providing more than 98% of its oil and natural gas requirements (Majid and Rahi, 2021: p.355). This is a natural consequence of the rapid rate of industrialization, developing economy, and notable increase in the Turkish population. As shown in Table (5), by 2023, Turkish imports from Egypt amounted to approximately 3,644,927 thousand USD. These imports were predominantly by-products, fertilizers, textile threads, and fibres, accounting for 17% and 8.24% of the total global Turkish imports, respectively. Egypt is recognized for its exports of standard quality fertilizers and chemical compounds, as well as spinning and textile threads, thus positioning it as a significant supplier of these products for Türkiye.

**Table 5.** *The Most Important Imports in 2023 (Thousand USD)*

Main Products	Total Imports	Imports from Egypt	Egypt's share
Mineral fuels, mineral oils and products of their distillation	69,115,358	481,237	0.6%
Natural or cultured pearls, precious or semi-precious stones, precious metals	33,912,165	74,739	0.22%
Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television.	27,824,279	204,679	0.74%
Iron and steel	24,160,653	353,938	1.5%
Plastics and articles thereof	16,214,536	421,178	2.6%
Inorganic chemicals + Organic chemicals	11,688,270	317,314	2.71%
Cereals	5,077,549	0.0	0.0%
Man-made filaments; strip and the like of man-made textile materials + Man-made staple fibres	3,839,525	316,719	8.24%
Fertilisers	2,374,008	411,710	17.34%

Source: ITC, 2024.

### 3. Conclusions

This study analyzes the development of foreign trade between Türkiye and Egypt, calculates trade concentration indicators, and examines the most significant commodities exchanged between these two nations. The findings indicate that despite fluctuations in political relations over time, both countries have recognized each other's economic and diplomatic importance. Historically, these nations have maintained social, cultural, and commercial ties, resulting in a pattern of stability that follows periods of tension. This research demonstrates that trade between Türkiye and Egypt has improved significantly and consistently, particularly after the implementation of a free trade agreement and other economic cooperation agreements. The volume of Türkiye's trade with Egypt in 2023 reached 6,982,229 thousand USD, compared to 954,545 thousand USD in 2005. However, despite Egypt's significance as a trading partner, the average volume of Türkiye's exports to Egypt as a percentage of total Turkish exports did not exceed 1.9%. Nevertheless, it is anticipated that the current improvement and stabilization of political relations will enhance this average and increase the economic cooperation between the two countries.

The study calculated trade concentration indicators for Türkiye, with export and import concentration indices above 1 ( $>1$ ) during the study period (2005-2023). The export concentration index reached 3.639 in 2023, from 4.964 in 2005, and peaked in 2009 at 7.031. In 2023, the import concentration index was 5.519, increasing from 2.210 in 2005, and peaking at 6.423 in 2018. For Egypt, the export and import concentration index values were greater than 1 from 2005 to 2023. The export concentration index value in 2023 reached 5.815, compared to 2.854 in 2005, and reached its highest value in 2018 at 6.009. The import concentration index value in 2023 reached 3.041 compared to 4.423 in 2005, and reached its highest values in 2009 and 2012 at 6.269 and 6.017, respectively. A comparison of the indicators in both countries reveals that the Turkish export concentration index is higher than the Egyptian export concentration index, suggesting that Turkish exports to Egypt have a higher concentration and volume than Egyptian exports to Türkiye. Similarly, Egypt has a higher import concentration index rating, indicating that a greater percentage of Turkish products enter the Egyptian market than Egyptian products into the Turkish market.

The diversity of resources in the Turkish economy has contributed to a substantial and varied export sector, particularly because of the high quality of its exports. Consequently, several Turkish goods have become prominent in its exports to Egypt, including automobiles, railway equipment, accessories, electrical appliances, and home furnishings. Conversely, energy materials have dominated Türkiye's imports, as they are industrialized nations with a growing population concentration, constituting approximately 20% of its total imports. Egyptian fibres and threads have also featured prominently in Türkiye's imports owing to the superior quality of Egyptian cotton and fibres.

Based on the presented data analysis, it can be concluded that bilateral trade between Egypt and Türkiye is mutually beneficial. Therefore, intensifying efforts to enhance political and economic relations will yield advantages to both parties. Through the free trade agreement between the two countries, they can capitalize on large and external economies of scale, particularly given their geographical proximity and ease of transporting production factors. Additionally, they can leverage each other's expertise in sectors where they possess a comparative advantage, such as the fertilizer, textile, automobile, and mechanical machinery industries.

There are numerous opportunities to strengthen the cooperation between Türkiye and Egypt, including economic integration. The primary opportunity lies in trade and investment, with Turkish investments in Egypt amounting to approximately 77.8 million USD, predominantly concentrated in the industrial sector, particularly in spinning, textiles, ready-made clothing, and chemical products. Other significant investment areas include glass products, recycling, tourism, and industrial development. Furthermore, the free trade agreement has significantly enhanced bilateral exports, resulting in trade exchanges exceeding 6 billion USD between the two countries.



Despite the profitability of this trade, it remains limited in comparison to both nations' potential, as well as the scale of their relationships and interdependence. Egyptian and Turkish markets exhibit diverse preferences that allow for increased trade between them, particularly in the agricultural sector. Because of the extreme cold in the winter season, Türkiye cannot cultivate crops that do not tolerate low temperatures, such as mangoes and citrus fruits, which Egypt is renowned for producing and exporting. Similarly, Türkiye is notable for its cultivation of high-quality nuts that are exported globally. The exchange of trade missions between the two countries would also enhance trade volume by facilitating increased communication between companies and governments. Furthermore, reducing dependence on the dollar and partially relying on national currencies (lira and pound) for bilateral trade can significantly contribute to creating mutual demand for both currencies.

In summary, there have been increasing and notable efforts to improve and strengthen Turkish-Egyptian relations; however, several challenges persist, including regional and international developments, differences in foreign policy objectives. Nevertheless, it is crucial that both countries continue to collaborate to enhance and strengthen their relations to achieve mutual interests, as they both recognize the importance of the other party politically and economically, both regionally and internationally.

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## The three-ways linkages between domestic investment, exports and economic growth: new evidence from Saudi Arabia

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**Abstract.** *This research paper aims to investigate the relationships between domestic investment, exports, and economic growth in Saudi Arabia from 2000 to 2021. Using cointegration and vector error correction model analyses, six key findings have emerged. Firstly, neither domestic investment nor exports have a significant long-term impact on economic growth. Secondly, long-term domestic investment does not significantly influence exports, and vice versa. Regarding long-term dynamics, the research reveals that economic growth and domestic investment positively influence exports over an extended period. Additionally, domestic investment and exports serve as causal factors for short-term economic growth. Furthermore, short-term relationships exist where economic growth and exports stimulate domestic investment, albeit with relatively weaker significance. Finally, the results highlight that economic growth and domestic investment jointly foster short-term export expansion. The research suggests the need to investigate additional economic, political, and structural factors beyond domestic investment and exports to better understand and enhance long-term economic growth in Saudi Arabia.*

**Keywords:** domestic investment, exports, economic growth, cointegration analysis, VECM, Saudi Arabia.

**JEL Classification:** C13, E22, F14, O47, O53.

## 1. Introduction

Saudi Arabia, as one of the most significant and influential economies in the Middle East, occupies a pivotal role in the global economic arena. Its vast wealth of natural resources, particularly its massive oil reserves, has been the cornerstone of its economic might for decades. These oil reserves have not only shaped Saudi Arabia's economic landscape but also positioned it as a key player in global energy markets. The revenue generated from oil exports has fueled extensive development projects, elevated living standards, and amassed substantial sovereign wealth. However, the heavy reliance on oil exports introduces a precarious vulnerability to the country's economy. The volatility of global oil prices, driven by geopolitical tensions, technological advancements in alternative energy sources, and shifting market dynamics, underscores the need for Saudi Arabia to diversify its economic base. As the global economy transitions towards sustainability and environmental stewardship, Saudi Arabia faces the imperative to innovate and seek sustainable pathways for long-term economic growth beyond its oil-dependent framework. This context raises crucial questions about the interplay between exports, domestic investments, and economic growth in Saudi Arabia. Understanding these dynamics is essential for crafting effective economic policies that can navigate the nation through an era of unprecedented global economic change. Exports, particularly of crude oil, have historically been the linchpin of Saudi economic strategy, generating substantial revenues that finance public expenditure and development projects. However, this hydrocarbon dependence creates a dual-edged sword—while it provides significant income, it also exposes the economy to external shocks and price fluctuations. On the other hand, domestic investments, encompassing both public and private sectors, are vital for building and enhancing the country's productive capacities. These investments stimulate economic growth, create jobs, and foster innovation. Therefore, a comprehensive analysis of how exports and domestic investments interact and influence Saudi Arabia's economic trajectory is imperative for understanding the broader implications for sustained economic growth.

This research aims to delve deeply into these complex and essential interconnections by examining the period from 2000 to 2021, a timeframe marked by significant economic and geopolitical events. During these two decades, Saudi Arabia witnessed considerable fluctuations in oil prices, implemented ambitious economic reforms under the Vision 2030 initiative, and navigated changes in the global trade landscape. These factors collectively shape the economic environment and provide a rich context for analyzing the intricate relationships between exports, domestic investments, and economic growth. To elucidate these relationships, we employ advanced econometric methodologies such as cointegration analysis and the Vector Error Correction Model (VECM). These tools enable us to identify both short-term and long-term trends and uncover potential causality links among the studied variables. The cointegration analysis helps determine whether a long-run equilibrium relationship exists between exports, domestic investments, and economic growth, while the VECM allows us to explore the dynamic adjustments towards this equilibrium. The findings of this research hold significant promise for providing valuable insights to policymakers, economists, investors, and other economic stakeholders within and beyond Saudi Arabia. By understanding the nuanced interactions between exports and domestic investments, policymakers can design strategies that mitigate the risks associated

with oil dependency and leverage domestic investments to diversify the economy. This, in turn, can enhance the economy's resilience to external shocks and foster sustained economic growth. For instance, policies that encourage investment in non-oil sectors such as technology, tourism, and renewable energy can create new revenue streams and job opportunities, thereby reducing the economy's vulnerability to oil price volatility. Moreover, insights from this research can inform investment strategies for both public and private sectors, guiding them towards areas with the highest potential for growth and development.

Furthermore, this study contributes to the broader academic discourse on economic development and diversification in resource-rich economies. By providing empirical evidence on the Saudi Arabian context, this research enriches our understanding of the economic dynamics in the Middle East, a region often characterized by its reliance on hydrocarbon resources. The lessons drawn from Saudi Arabia's experience can offer valuable insights for other resource-dependent economies seeking to diversify and achieve sustainable growth. Additionally, the use of advanced econometric techniques such as cointegration analysis and VECM adds methodological rigor to the study, setting a precedent for future research on similar topics. This can pave the way for new research perspectives and stimulate further academic inquiry into the factors driving economic growth and diversification in resource-rich countries. The remainder of this work is structured to provide a comprehensive analysis of the topic. In the second section, we present a literature review that explores existing research on the link between exports, domestic investments, and economic growth. This review provides a theoretical foundation for our study, highlighting key findings and identifying gaps in the current knowledge. The third section details our empirical methodology, explaining the data sources, econometric models, and analytical techniques employed in the study. This section aims to provide a clear and transparent account of our research approach, ensuring the replicability and validity of our findings. In the fourth section, we present our empirical results, discussing the implications of our findings and their relevance to the Saudi Arabian context. Finally, in the fifth section, we conclude the study by summarizing the key insights and offering recommendations for policymakers and economic stakeholders. These recommendations are intended to guide future economic strategies and contribute to the ongoing discourse on sustainable development and economic diversification.

## 2. Literature survey

The linkages between domestic investment, exports, and economic growth are fundamental to understanding economic development and crafting effective economic policies. This section delves into the theoretical foundations and empirical evidence related to these relationships. It outlines how domestic investment contributes to economic growth by enhancing productive capacity, how exports drive growth by expanding market access and generating foreign exchange, and how these factors interrelate to create a dynamic economic environment. A comprehensive understanding of these interactions is crucial for policymakers aiming to design strategies that promote sustainable economic development.

## **2.1. Theoretical background**

Understanding the theoretical linkages between domestic investment, exports, and economic growth is essential for a comprehensive analysis of economic development. Examining these relationships offers valuable insights into how economies function and grow, which is critical for formulating effective economic policies. Here's an in-depth explanation of the importance of studying these linkages, supported by relevant literature.

### **2.1.1. The Role of Domestic Investment**

Domestic investment, both public and private, is a cornerstone of economic growth. According to Solow's (1956) growth model, investments in capital enhance a country's productive capacity, leading to increased output and growth. Public investments in infrastructure and education provide the necessary foundation for private investments to thrive, as highlighted by Barro (1990). For instance, a well-developed transport network reduces logistics costs, and a skilled workforce boosts productivity. Private investments directly contribute to the production of goods and services, fostering innovation and efficiency, as discussed by Romer (1990). Moreover, investments generate employment opportunities, increase income levels, and stimulate demand for goods and services, creating a virtuous cycle of growth. Endogenous growth theories, such as those proposed by Lucas (1988), emphasize that investment in human capital, innovation, and knowledge can lead to sustained economic growth. Thus, understanding the impact of domestic investment on economic growth helps policymakers identify the most effective areas to allocate resources to maximize growth outcomes.

### **2.1.2. The Importance of Exports**

Exports are crucial for economic growth as they provide access to larger markets beyond the domestic economy. Classical trade theories by Smith (1776) and Ricardo (1817) suggest that exports allow countries to specialize in producing goods and services where they have a comparative advantage, leading to more efficient resource allocation and higher productivity. Krugman (1980) further supports this by highlighting how exporting firms can achieve economies of scale, reducing per-unit costs and increasing competitiveness in international markets. Exports also generate foreign exchange earnings, essential for importing goods and services not produced domestically. Export-led growth models, as discussed by Balassa (1978), argue that increased exports lead to higher economic growth by stimulating production, increasing income, and improving the balance of payments. Understanding the impact of exports on economic growth helps design trade policies that promote export diversification and competitiveness.

### **2.1.3. Economic Growth and Its Drivers**

Economic growth, defined as the increase in a country's output of goods and services over time, is a key indicator of economic development and prosperity. The Solow growth model (1956) identifies capital accumulation, labor force growth, and technological progress as primary drivers of growth. In this context, both domestic investment and exports are crucial components that drive these factors. Domestic investment contributes to capital accumulation, enhancing productive capacity. Exports open up new markets and increase



demand, encouraging firms to invest in expanding production capabilities. Moreover, exports can lead to technology transfer and innovation, as firms strive to remain competitive in the global market (Grossman and Helpman, 1991). The interaction between these factors creates a dynamic process where investment and exports mutually reinforce each other, leading to sustained economic growth.

#### **2.1.4. Interconnectedness of the Three Variables**

The theoretical linkages between domestic investment, exports, and economic growth are interconnected and mutually reinforcing. Domestic investment increases productive capacity, enabling the production of more goods for both domestic consumption and export. Higher exports generate additional revenue and foreign exchange, which can be reinvested in the economy, further boosting investment and growth. According to endogenous growth theory, investment in human capital, innovation, and knowledge leads to sustained economic growth (Romer, 1986). Similarly, the export-led growth hypothesis suggests that increased exports stimulate economic growth by expanding market size and encouraging efficiency (Feder, 1983). The new trade theory by Krugman (1980) also highlights the role of economies of scale and network effects in driving growth through trade.

Understanding the theoretical linkages between domestic investment, exports, and economic growth has significant policy implications. Policymakers need to design strategies that foster a conducive environment for investment, promote export diversification, and ensure sustainable economic growth. Policies that improve infrastructure, enhance education and skills, and support technological innovation can attract domestic and foreign investment (Barro, 1990). Trade policies that reduce barriers, improve market access, and enhance competitiveness can boost exports (Krugman, 1980). A comprehensive understanding of these linkages helps identify potential trade-offs and complementarities. Excessive reliance on exports without sufficient domestic investment can lead to vulnerabilities to external shocks, while focusing solely on domestic investment without promoting exports can limit growth opportunities. Balanced policies integrating domestic investment and export promotion are essential for achieving sustainable economic growth (Rodrik, 2008). The theoretical importance of studying the linkages between domestic investment, exports, and economic growth lies in the comprehensive understanding it provides of how economies function and grow. These linkages are interconnected and mutually reinforcing, creating a dynamic process that drives sustained economic growth. By understanding these relationships, policymakers can design effective strategies that foster investment, promote exports, and ensure sustainable economic development. This theoretical exploration is essential for identifying the most effective policy interventions to maximize growth outcomes and improve economic prosperity.

## **2.2. Empirical evidence**

This section presents empirical evidence on the causal relationships between Foreign Direct Investment (FDI), exports, domestic investment, and economic growth, based on various studies conducted across different countries and regions. Utilizing methodologies such as panel Granger causality tests, Johansen's multivariate cointegration approach, and vector

error correction models (VECM), these studies reveal intricate dynamics among these economic variables. The findings highlight the varying influences of FDI, exports, and domestic investment on economic growth, offering insights for policymakers on fostering sustainable economic development. Sooreea-Bheemul and Sooreea (2013) utilize panel Granger causality techniques to explore the long-term causal relationships among FDI, exports, domestic investment, and economic growth in 28 developing and emerging countries from 1980 to 1998. Their findings reveal unidirectional causality from economic growth to domestic investment, but bi-directional causality between other variable pairs. FDI is found to be superior to domestic investment in terms of spillover and linkage effects, driving exports and economic growth, which in turn attract more FDI. Despite the absence of a direct causal link from domestic investment to economic growth, the study emphasizes the importance of not neglecting domestic investors in favor of FDI and exports. Shawa and Grafoute (2014) analyze the causal relationships between FDI, GDP growth, domestic investment, and exports in Kenya from 1980 to 2013 using cointegration and Granger causality tests. The results indicate long-term relationships among the variables. Specifically, exports predict domestic investment, and a bidirectional relationship exists between exports and FDI. Additionally, domestic investment predicts FDI inflows, suggesting that policies should consider these dynamics to achieve desired economic outcomes. Keho (2015) examines the relationships among FDI, exports, and economic growth in 12 sub-Saharan African countries from 1970 to 2013 using Johansen's multivariate cointegration approach. The findings reveal co-integration among the variables in ten countries, with economic growth positively affecting FDI in five countries and exports being positively related to FDI in four countries. Granger causality tests show mixed results, with various forms of causality between FDI, GDP, and exports across different countries. The study supports FDI and export-promoting policies based on these empirical insights. Tsitouras and Nikas (2016) apply time series and panel data cointegration analysis to investigate the causal relationships between exports, inward FDI, and GDP in 15 European transition economies from 1995 to 2014. The study includes domestic investment and government spending as auxiliary variables. The results validate the export-led growth and FDI-led growth hypotheses primarily for economies that joined the EU in 2004, while other economies benefit from a culture of saving that enhances local investment and export capacity. Ullah et al (2014) explore the interactions between domestic investment, FDI, and economic growth in Pakistan from 1976 to 2010 using the Johansen cointegration approach and Toda-Yamamoto causality tests. The study finds a long-term relationship among the variables and bidirectional causality between FDI and domestic investment, indicating mutual reinforcement.

In the context of Japan, Bakari (2017) conducted an analysis to assess the impact of exports and domestic investment on economic growth from 1970 to 2015. Utilizing ordinary least squares regression, the empirical findings revealed a positive association between domestic investment, exports, and economic growth. This suggests that both domestic investment and exports are significant drivers of Japan's economic growth. Turning to Nigeria, Bakari et al. (2018) investigated the interplay among exports, domestic investment, and economic growth for the duration of 1981 to 2015. Employing cointegration analysis and a vector error correction model, the empirical results indicated the absence of a long-term

relationship between exports, domestic investment, and economic growth. This implies that other factors may play a more critical role in Nigeria's long-term economic performance. Similarly, in their study of India, Fakraoui and Bakari (2019) scrutinized the relationship between exports, domestic investment, and economic growth during the period of 1960 to 2017. The empirical findings corroborated the absence of a long-term relationship between exports, domestic investment, and economic growth. This lack of long-term association suggests that India's economic growth may be influenced by different determinants over an extended period. Within the context of Uruguay, Bakari et al. (2019) found no discernible impact of exports and domestic investment on long-term economic growth during the period spanning from 1960 to 2017. However, in the short term, they observed that only exports were a causal factor for economic growth. This highlights the significance of exports as a short-term driver of Uruguay's economic performance, while domestic investment appears less influential in the short run. In the case of Peru, Bakari et al. (2020) examined the nexus between exports, domestic investment, and economic growth over the period from 1970 to 2017. Employing cointegration analysis and a vector error correction model, their findings revealed an absence of both a long-term and short-term relationship between domestic investment, exports, and economic growth. This suggests that neither exports nor domestic investment significantly influence Peru's economic growth within the studied timeframe. For the United States, Bakari and Tiba (2019) determined that domestic investment and exports had a long-term impact on economic growth during the period spanning from 1970 to 2019, as evidenced by their application of a vector error correction model. This finding underscores the importance of both domestic investment and exports as long-term growth drivers for the U.S. economy.

Bakari (2022) scrutinized the relationship between exports, domestic investment, and economic growth in Greece from 1970 to 2020. Utilizing cointegration analysis and a vector error correction model, the empirical results indicated a lack of both long-term and short-term relationships between exports, domestic investment, and economic growth. This suggests that these variables may not be the primary determinants of Greece's economic growth. In the case of 14 MENA countries, Taiwo-Onifade et al. (2022) found that domestic investment positively impacts economic growth during the period from 2003 to 2017. Additionally, they discovered that trade has a negative impact on economic growth, highlighting the complex and varying influences of these factors on economic performance in the MENA region. Bakari (2016a) examined the relationship between exports, imports, and economic growth in Canada using data from 1990 to 2015. By applying Johansen cointegration analysis, the Vector Auto Regression Model, and Granger-Causality tests, Bakari found no long-term relationship between exports, imports, and economic growth. However, there was strong evidence of bidirectional causality from imports to economic growth and from exports to economic growth. This indicates that, in the short run, both imports and exports are significant drivers of economic growth in Canada. Bakari (2016b) also investigated the relationship between domestic investment and economic growth in Canada for the same period. Using correlation analysis, Johansen co-integration, and the Vector Error Correction Model, the study concluded that there is no long-term relationship between domestic investment and economic growth. However, in the short run, there was

a weak relationship, suggesting that domestic investment influences economic growth over shorter periods, though it does not cause economic growth in the long run.

In their study on Arab countries, Bakari and El Weriemmi (2022) used data from 1990 to 2020 and the Vector Error Correction Model to explore the nexus between domestic investment and economic growth. Their findings showed no long-term relationship, but there was bidirectional causality in the short run. This suggests that while domestic investment is necessary and can drive short-term economic growth, long-term growth requires more consistent and effective investment policies. Yedder et al (2023a) focused on North African countries using the Panel CS-ARDL Model to analyze data from 1990 to 2021. Their study revealed that domestic investment and exports do not significantly impact long-term economic growth. However, imports had a positive long-term effect. This highlights the complex economic organization and instability in the region, which hinders the effectiveness of domestic investments and exports in promoting sustained growth. Yedder et al (2023b) explored the interplay between domestic investments, exports, and economic growth in Angola from 2002 to 2022. Using cointegration analysis and the ARDL model, their study found no significant impact of domestic investments and exports on long-term economic growth. These unexpected results challenge conventional economic theories and suggest the need for a reevaluation of Angola's economic policies. Akermi et al (2024) studied the impact of final consumption, domestic investment, exports, and imports on Albania's economic growth from 1996 to 2021. Using cointegration analysis, VECM, and the WALD test, they found no causality between these variables and economic growth in both the short and long run. This points to Albania's critical economic situation, necessitating urgent reforms and strong strategies to stimulate growth. Othmani et al (2023) investigate the interplay between patents, domestic investment, and economic growth in the USA from 1980 to 2020 using cointegration analysis and the VECM model. Their findings indicate the absence of a long-term causal relationship between these three variables. However, in the short run, domestic investment and economic growth influence patenting activity, suggesting that patents are not primary drivers of economic growth and domestic investment in the USA. Instead, other factors are likely stimulating American economic activity. In their study, Ben Yedder et al (2023) explore the role of patents in the relationship between domestic investment and economic growth in MENA countries from 1998 to 2022 using panel data analysis. The empirical results demonstrate that domestic investment positively impacts economic growth, while patents do not significantly influence it. Additionally, the impact of domestic investment on economic growth remains unaffected by patent activity, highlighting the limited role of patents in the economic development of these countries. Pegkas and Tsamadias (2016) investigate the causal relationship between economic growth and its determinants (FDI, domestic investment, exports, and human capital) in Greece from 1970 to 2012. Using time series analysis, they find that all determinants positively affect economic growth in the long run. However, structural reforms are necessary to enhance these contributions. Mamun and Kabir (2023) analyze the impact of remittances, FDI, and exports on Bangladesh's economic growth from 1976 to 2019 using ARDL bounds tests. The study identifies positive roles for remittances and exports, but a negative role for FDI, suggesting policy adjustments to foster long-term growth, especially considering recent global events. Öncel et al (2024) examine

the relationship between financial development indicators, export performance, and economic growth in nine Commonwealth of Independent States from 1995 to 2020. Using PVAR analysis and VECM, they find positive impacts of financial development and export on economic growth, though the effect of gross capital formation is inconclusive. The study highlights the significant positive impact of financial development and exports on long-term economic growth.

The empirical studies reviewed demonstrate a diverse range of relationships between FDI, exports, domestic investment, and economic growth. While some countries exhibit bidirectional or unidirectional causality among these variables, others show no long-term relationships. These variations underscore the importance of context-specific economic conditions and policies. The results suggest that while domestic investment and exports play significant roles in driving economic growth in the short term, long-term effects may depend on additional factors and effective policy measures. The findings highlight the need for tailored economic strategies that consider the unique dynamics of each country's economic environment to achieve sustained growth.

### 3. Empirical methodology

In this section, we outline the empirical methodology employed to examine the relationships among domestic investments, exports, and economic growth in Saudi Arabia. This investigation is structured into three key components: the description of the dataset, the methodology for analysis, and the model specification. By systematically presenting these elements, we aim to provide a clear framework for understanding how domestic investments and exports influence economic growth, utilizing data spanning from 2000 to 2021. Our approach incorporates time series analysis, drawing from established models and techniques to uncover the intricate dynamics at play.

#### 3.1. Data

To investigate the relationship among domestic investment, exports, and economic growth in Saudi Arabia, we will employ a time series dataset covering the period from 2000 to 2021. This dataset is derived from the annual statistical reports provided by the World Bank, which offers comprehensive and reliable economic indicators. The dataset includes three primary variables:

- **Economic Growth (Y):** Represented by Gross Domestic Product (GDP) measured in constant 2015 US dollars. This variable captures the overall economic output and growth of Saudi Arabia over the specified period. Using constant dollars allows us to adjust for inflation and thus provides a more accurate measure of real economic growth.
- **Exports (X):** This variable accounts for the value of goods and services exported by Saudi Arabia, also measured in constant 2015 US dollars. The constant price adjustment ensures that the data reflects the real value of exports without the distortion of inflationary effects. This measure is crucial for understanding how changes in export levels impact economic growth.

- **Domestic Investment (DI):** Represented by Gross Fixed Capital Formation (GFCF) in constant 2015 US dollars. GFCF includes expenditures on physical assets like buildings, machinery, and infrastructure, which are essential for productive capacity and long-term economic development. Again, constant prices are used to provide an accurate reflection of real investment levels over time.

**Table n°1.** *Description of variables*

No	Variable	Explanation	Description	Source
1	Y	Economic Growth	GDP (constant 2015 US\$)	World Bank Indicators
2	X	Exports	Exports of goods and services (constant 2015 US\$)	World Bank Indicators
3	DI	Domestic investment	Gross fixed capital formation (constant 2015 US\$)	World Bank Indicators

**Source:** Built by the authors.

The dataset's use of constant prices for GDP, exports, and domestic investment ensures that our analysis is not skewed by inflationary changes. This approach allows for a clearer examination of the real relationships and effects among these variables, facilitating a more accurate assessment of how domestic investments and exports influence economic growth in Saudi Arabia.

### 3.2. Methodology

To investigate the relationship among domestic investment, exports, and economic growth in Saudi Arabia, our empirical methodology will leverage the Sims (1980) model, a sophisticated approach well-suited for analyzing time series data. The Sims model is particularly advantageous for our study due to several key merits that align with our analytical objectives. One of the primary strengths of the Sims model is its ability to explore co-integration among variables. Co-integration refers to a statistical property where non-stationary time series variables move together in the long run, despite being individually non-stationary. This is crucial in our context because it helps us understand whether a long-term equilibrium relationship exists between domestic investment, exports, and economic growth. By identifying such relationships, we can better grasp how these variables interact over time and how shocks in one variable might impact the others in the long run.

The Sims model provides a more realistic approximation of economic relationships compared to alternative models, especially when dealing with a manageable number of variables, typically five or fewer. This feature is particularly useful for our analysis, as it allows us to maintain model simplicity while capturing the essential dynamics between the variables. By focusing on a smaller set of variables, we can reduce the complexity of the model and avoid overfitting, which enhances the reliability of our findings. Another significant advantage of the Sims model is its capability to assess causal links between short-term and long-term variables. Assuming that co-integration is present, the model can help distinguish between short-term fluctuations and long-term trends. This distinction is important for understanding how temporary changes in domestic investment or exports might affect economic growth in the short run, and how these effects persist or evolve over the long term. This approach provides a nuanced view of the causal relationships, which is vital for developing effective economic policies.

The Sims model is well-suited for studies involving time series data, which is precisely the type of data we are analyzing. Time series analysis involves examining data points collected or recorded at specific time intervals, and the Sims model's design accommodates the unique challenges associated with such data, including serial correlation and trends. This suitability ensures that our analysis will effectively handle the intricacies of time series data and provide robust results. Our empirical approach will start with assessing the stationarity of the variables using the Augmented Dickey-Fuller (ADF) test. Stationarity is a crucial prerequisite for reliable time series analysis, as non-stationary data can lead to misleading results. If our variables are not stationary at the level, we will difference them and re-test for stationarity in the first differences.

Following this, we will conduct co-integration analysis using the Johansen Test. This test will help us identify whether a long-term equilibrium relationship exists among the variables. If the Johansen Test indicates the presence of co-integration, we will employ the Vector Error Correction Model (VECM) to analyze the short-term dynamics and long-term relationships between the variables.

Additionally, the Wald Test will be used within the VECM framework to test the significance of the parameters. In cases where co-integration is not detected, we will turn to the Vector Autoregression (VAR) Model and the Granger Causality Test. The VAR model will allow us to capture the linear interdependencies among the variables, while the Granger Causality Test will help us determine the direction of causality between them. By following this comprehensive empirical methodology, we aim to uncover the intricate relationships among domestic investment, exports, and economic growth in Saudi Arabia, providing valuable insights for policymakers and researchers interested in understanding and enhancing economic development.

### 3.3. Model specification

To analyze the causal relationships among exports, domestic investment, and economic growth, we will use a neoclassical model framework. This model helps us understand how these variables interact and influence one another within the context of economic growth. The neoclassical model posits that economic growth is driven by factors such as capital accumulation, technological progress, and labor force expansion. In this study, we focus on how domestic investment and exports contribute to economic growth, particularly in the context of Saudi Arabia. The fundamental equation for our analysis can be expressed as:

$$Y = F [DI, X] \quad (1)$$

The function (1) can also be reproduced in a log-linear econometric format thus:

$$\text{Log}(Y)_t = \alpha_0 + \alpha_1 \text{Log}(DI)_t + \alpha_2 \text{Log}(X)_t + \varepsilon_t \quad (2)$$

Where:

$\alpha_0$ : is the constant term

$\alpha_1$ : is the coefficient of domestic investment

$\alpha_2$ : is the coefficient of exports

$\varepsilon$ : is the random error term

t: is the time trend.

By applying this model, we aim to quantify how domestic investment and exports individually and jointly affect economic growth. The coefficients  $\alpha_1$  and  $\alpha_2$  provide insights into the relative importance of each factor. For instance, a higher  $\alpha_1$  would indicate that domestic investment has a significant impact on economic growth, whereas a high  $\alpha_2$  would highlight the importance of exports. After establishing this theoretical framework, we will employ the dataset to conduct an empirical investigation. This investigation will assess the relationships between exports, domestic investment, and economic growth, using data from Saudi Arabia. Our approach involves examining both short-term and long-term effects, and evaluating how these variables interact over time. This comprehensive analysis will help in understanding the dynamics at play and inform policy recommendations aimed at fostering economic growth through effective investment and trade strategies.

#### 4. Empirical results

This section presents the empirical results of our study on the dynamic relationships between economic growth, domestic investment, and exports in Saudi Arabia. We begin with a stationarity analysis using the Augmented Dickey-Fuller (ADF) unit root test to determine the stationarity of the variables under study. This is followed by an examination of the optimal lag order selection using various criteria such as the Log-Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), and Hannan-Quinn Information Criterion (HQ). Finally, we perform a cointegration analysis using the Johansen test to explore the long-term equilibrium relationships among the variables and apply the Vector Error Correction Model (VECM) to understand both the long-run and short-run dynamics.

##### 4.1. Stationarity analysis

The table n<sup>o</sup>2 presents the results of the Augmented Dickey-Fuller (ADF) unit root test for three economic variables: economic growth (LOG(Y)), domestic investment (LOG(DI)), and exports (LOG(X)), evaluated both at level and at first difference. The examination of the results at the level reveals that none of the variables are stationary. For LOG(Y) (economic growth), the t-statistic is -1.2639 with a p-value of 0.6261 when including a constant, indicating non-stationarity at this level. Similarly, LOG(DI) (domestic investment) has a t-statistic of -2.4009 with a p-value of 0.1534, further suggesting that this series is non-stationary. LOG(X) (exports) shows a t-statistic of -1.7820 with a p-value of 0.3784, which also confirms non-stationarity at the level. When considering both a constant and a trend, the situation remains unchanged. LOG(Y) displays a t-statistic of -0.8014 with a p-value of 0.9493, reinforcing its non-stationarity at the level. LOG(DI) has a t-statistic of -0.2613 with a p-value of 0.9862, indicating that it is also non-stationary. For LOG(X), the t-statistic is -2.4506 with a p-value of 0.3457, confirming the absence of stationarity. Without including constant and trend, the t-statistics are positive (3.3975 for LOG(Y), 1.5144 for LOG(DI), and 0.6691 for LOG(X)), and the p-values are extremely high, confirming non-stationarity at the level.



**Table n°2.** Results of Unit Root Test (ADF)

At Level				
Variables		LOG(Y)	LOG(DI)	LOG(X)
With Constant	t-Statistic	-1.2639	-2.4009	-1.7820
	Prob.	0.6261	0.1534	0.3784
With Constant & Trend	t-Statistic	-0.8014	-0.2613	-2.4506
	Prob.	0.9493	0.9862	0.3457
Without Constant & Trend	t-Statistic	3.3975	1.5144	0.6691
	Prob.	0.9994	0.9628	0.8526
At First Difference				
Variables		d(LOG(Y))	d(LOG(DI))	d(LOG(X))
With Constant	t-Statistic	-3.7087	-2.6286	-4.2806
	Prob.	0.0124	0.1040	0.0037
With Constant & Trend	t-Statistic	-4.1001	-4.7703	-4.4000
	Prob.	0.0217	0.0084	0.0121
Without Constant & Trend	t-Statistic	-2.5277	-2.0440	-4.2696
	Prob.	0.0144	0.0419	0.0002

**Notes:** (\*)Significant at the 10%; (\*\*)Significant at the 5%; (\*\*\*) Significant at the 1%.

\*MacKinnon (1996) one-sided p-values.

**Source:** Authors' calculations using EViews 12 software.

The results of the unit root test at first difference show that all variables become stationary. For  $d(\text{LOG}(Y))$ , the t-statistic is -3.7087 with a p-value of 0.0124 when including a constant, indicating stationarity after differencing.  $d(\text{LOG}(DI))$  has a t-statistic of -2.6286 with a p-value of 0.1040, showing stationarity in first difference, though the p-value is close to the 10% significance threshold.  $d(\text{LOG}(X))$  shows a t-statistic of -4.2806 with a p-value of 0.0037, confirming stationarity after differencing. When both a constant and a trend are included,  $d(\text{LOG}(Y))$  has a t-statistic of -4.1001 with a p-value of 0.0217, indicating stationarity.  $d(\text{LOG}(DI))$  displays a t-statistic of -4.7703 with a p-value of 0.0084, also confirming stationarity.  $d(\text{LOG}(X))$  has a t-statistic of -4.4000 with a p-value of 0.0121, which further indicates stationarity. Without constant and trend,  $d(\text{LOG}(Y))$  presents a t-statistic of -2.5277 with a p-value of 0.0144, showing stationarity.  $d(\text{LOG}(DI))$  has a t-statistic of -2.0440 with a p-value of 0.0419, confirming stationarity.  $d(\text{LOG}(X))$  shows a t-statistic of -4.2696 with a p-value of 0.0002, which also confirms stationarity. The results demonstrate that all the variables under consideration—economic growth, domestic investment, and exports—are stationary after first differencing. This finding suggests that co-integration analysis is appropriate to investigate the long-term relationships among these variables. Given the stationarity results, we will proceed with the Sims co-integration model for our analysis. This model is well-suited for examining long-term equilibrium relationships and complex interactions among variables, particularly in the context of time series data. The Sims model will help assess long-term relationships and identify potential causal connections among the variables.

#### 4.2. Lag order selection criteria

Table n°3 presents the results of the VAR (Vector Autoregression) Lag Order Selection Criteria for the variables  $D\text{LOG}(Y)$ ,  $D\text{LOG}(DI)$ , and  $D\text{LOG}(X)$ . This analysis is crucial for determining the optimal number of lags to include in the model to accurately capture the dynamic relationships among the variables. The table lists several key criteria used to

select the appropriate lag order: LogL (Log-Likelihood), LR (Sequential Modified Likelihood Ratio Test Statistic), FPE (Final Prediction Error), AIC (Akaike Information Criterion), SC (Schwarz Information Criterion), and HQ (Hannan-Quinn Information Criterion). Each criterion provides a different perspective on the model's fit and complexity, balancing the trade-off between goodness of fit and the number of parameters included. The results for different lag orders (0 to 3) are displayed in the table, showing the values of each criterion for each lag. The asterisks (\*) indicate the optimal lag order selected by each criterion. Notably, the second lag (Lag 2) is identified as the optimal lag order by most criteria:

- LR (Sequential Modified Likelihood Ratio Test Statistic) shows that Lag 2 significantly improves the model fit, with a value of 20.46506.
- FPE (Final Prediction Error) suggests that Lag 2 has the lowest prediction error (6.76e-09).
- AIC (Akaike Information Criterion) is minimized at Lag 2, with a value of -10.42767.
- HQ (Hannan-Quinn Criterion) also points to Lag 2 as the optimal choice, with a value of -10.28444.
- While the SC (Schwarz Criterion) indicates that Lag 0 might be optimal (value of -9.810026), the majority of criteria agree on Lag 2. The SC tends to select models with fewer parameters due to its heavier penalty for additional parameters.

**Table n°3. Results of Lag Order Selection Criteria**

VAR Lag Order Selection Criteria						
Endogenous variables: DLOG(Y) DLOG(DI) DLOG(X)						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	92.62579	NA	9.50e-09	-9.958421	-9.810026*	-9.937959
1	98.10491	8.523079	1.44e-08	-9.567213	-8.973631	-9.485366
2	114.8490	20.46506*	6.76e-09*	-10.42767*	-9.388905	-10.28444*
3	121.7954	6.174547	1.14e-08	-10.19949	-8.715538	-9.994873

\* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

**Source:** Authors' calculations using EViews 12 software.

Economically, selecting a lag order of 2 years implies that the interactions between the variables—economic growth (DLOG(Y)), domestic investment (DLOG(DI)), and exports (DLOG(X))—are best captured when considering a two-year time horizon. This means that the effects of changes in domestic investment and exports on economic growth, and vice versa, manifest most significantly over a period of two years. Given the annual frequency of the dataset, this lag selection reflects a realistic timeframe for observing the dynamic impacts among these economic indicators. The VAR Lag Order Selection Criteria collectively suggest that a lag order of 2 is optimal for the model. This choice allows for a comprehensive and accurate representation of the temporal interdependencies among economic growth, domestic investment, and exports in Saudi Arabia. Consequently, the subsequent analysis and modeling will incorporate a two-year lag to ensure robust and meaningful results.

### 4.3. Cointegration analysis

Table n°4 presents the results of the Johansen cointegration test, which is employed to determine the existence of long-term equilibrium relationships among the variables in our study: economic growth (LOG(Y)), domestic investment (LOG(DI)), and exports (LOG(X)). The Johansen test comprises two parts: the Trace test and the Maximum Eigenvalue test. In the Trace test, the hypothesis is that there are no cointegrating equations (CEs). The null hypothesis is rejected if the trace statistic exceeds the critical value at the 5% significance level. The results show that for the null hypothesis of no cointegration (None), the trace statistic is 38.27943, which is higher than the critical value of 29.79707, with a p-value of 0.0042. This indicates rejection of the null hypothesis at the 5% significance level, suggesting the presence of at least one cointegrating equation. For the hypotheses of at most one and at most two cointegrating equations, the trace statistics are 9.385172 and 2.702706, respectively, which are lower than their corresponding critical values, indicating that additional cointegrating equations are not significant.

The Maximum Eigenvalue test also examines the number of cointegrating equations by comparing the maximum eigenvalue statistic with the critical value. For the null hypothesis of no cointegration, the maximum eigenvalue statistic is 28.89426, which exceeds the critical value of 21.13162, with a p-value of 0.0033. This result confirms the presence of one cointegrating equation. The tests for at most one and at most two cointegrating equations show maximum eigenvalue statistics of 6.682466 and 2.702706, respectively, which do not exceed their critical values, indicating no further cointegration.

**Table n°4.** Results of Johansen Test

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0,05 Critical Value	Prob.**
None *	0.799158	38.27943	29.79707	0.0042
At most 1	0.310127	9.385172	15.49471	0.3309
At most 2	0.139421	2.702706	3.841466	0.1002
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0,05 Critical Value	Prob.**
None *	0.799158	28.89426	21.13162	0.0033
At most 1	0.310127	6.682466	14.26460	0.5273
At most 2	0.139421	2.702706	3.841466	0.1002

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

Source: Authors' calculations using EViews 12 software.

Both the Trace test and the Maximum Eigenvalue test consistently indicate the existence of one cointegrating equation among the variables. This finding supports the presence of a long-term equilibrium relationship between economic growth, domestic investment, and exports in Saudi Arabia. As a result, we will employ the Vector Error Correction Model (VECM) in subsequent analyses. The VECM is suitable for capturing both the long-term relationships and short-term dynamics among the variables, allowing for a comprehensive understanding of their interactions.

#### 4.4. Estimation of VECM models in the long run

Table n°5 presents the results of the long-term estimation of the Vector Error Correction Model (VECM). This model is used to examine the long-term relationships between economic growth (LOG(Y)), domestic investment (LOG(DI)), and exports (LOG(X)). The VECM provides insights into how these variables interact over an extended period, capturing both the short-term fluctuations and long-term equilibrium dynamics. Firstly, the analysis indicates that neither domestic investment nor exports have a significant long-term impact on economic growth. The coefficients for LOG(DI) and LOG(X) in the equation for LOG(Y) are not statistically significant, as evidenced by their t-statistics and corresponding p-values. This suggests that, in the context of Saudi Arabia, changes in domestic investment and exports do not significantly drive long-term economic growth. Instead, other factors not included in the model may play a more crucial role in influencing the country's economic growth trajectory over the long run.

Secondly, the results show that domestic investment does not significantly influence exports in the long term, and exports do not significantly influence domestic investment either. The coefficients for LOG(DI) in the LOG(X) equation and LOG(X) in the LOG(DI) equation are both statistically insignificant. This finding implies that, while domestic investment and exports are essential components of the economy, their long-term interdependence is not strong. The lack of a significant long-term relationship between these two variables suggests that their effects on each other are either indirect or mediated by other economic factors.

However, the research reveals that both economic growth and domestic investment positively influence exports over an extended period. Specifically, a 1% increase in economic growth leads to a 0.104175% increase in exports, and a 1% increase in domestic investment results in a 0.145555% increase in exports in the long term. These findings highlight the importance of economic growth and domestic investment in boosting the country's export performance. The positive relationship between economic growth and exports suggests that as the economy expands, the production capacity and competitiveness of domestic industries improve, leading to higher export volumes. Similarly, increased domestic investment enhances the infrastructure, technology, and productivity of export-oriented sectors, contributing to greater export growth.

**Table n°5.** Results of VECM models in the long run

	Log (Y)	Log (DI)	Log (X)
Log (Y)		- 0.715708	0.104175***
		(1.80059)	(0.26646)
		[0.39748]	[-0.39096]
Log (DI)	- 1.397219		0.145555***
	(0.53082)		(0.07031)
	[2.63218]		[-2.07028]
Log (X)	9.599239	6.870249	
	(1.48217)	(1.32658)	
	[-6.47646]	[-5.17893]	
C	- 0.056417	0.040378	0.005877

Standard errors in ( ) & t-statistics in [ ]

**Notes:** (\*)Significant at the 10%; (\*\*)Significant at the 5%; (\*\*\*) Significant at the 1%.

**Source:** Authors' calculations using EViews 12 software.

The results also underscore the complexity of the relationships between economic variables in the long term. While domestic investment and exports do not significantly impact economic growth, they are crucial for enhancing the country's export capabilities. This dynamic indicates that the benefits of domestic investment and economic growth are more apparent in the export sector rather than directly influencing overall economic growth. The positive impact of economic growth and domestic investment on exports suggests that policies aimed at fostering economic expansion and encouraging domestic investment can have significant spillover effects on the export sector, thereby enhancing the country's trade performance.

The VECM results provide valuable insights into the long-term interactions between economic growth, domestic investment, and exports in Saudi Arabia. While domestic investment and exports do not directly drive long-term economic growth, they play a crucial role in boosting the country's export performance. The positive relationships between economic growth, domestic investment, and exports highlight the importance of fostering economic policies that promote overall economic expansion and encourage domestic investment. These policies can lead to substantial improvements in the export sector, contributing to the country's trade balance and economic resilience in the long run.

#### **4.5. Estimation of VECM models in the short run**

Table n°6 presents the results of the short-term estimation of the Vector Error Correction Model (VECM). This model is designed to capture the immediate interactions and adjustments between economic growth ( $\text{LOG}(Y)$ ), domestic investment ( $\text{LOG}(DI)$ ), and exports ( $\text{LOG}(X)$ ) within a shorter time frame. The short-term dynamics offer valuable insights into how these variables influence each other in the short run, providing a nuanced understanding of their causal relationships.

The results indicate that domestic investment and exports serve as significant causal factors for short-term economic growth. This finding suggests that increases in domestic investment and export activities can lead to immediate improvements in economic performance. For instance, when businesses invest in new projects, equipment, or infrastructure, the immediate effect is often an increase in economic activity, job creation, and productivity, all of which contribute to short-term economic growth. Similarly, an uptick in exports can boost the economy by increasing production demand, generating foreign exchange earnings, and fostering economic activities linked to the export sectors.

Furthermore, the results reveal that there are short-term relationships where economic growth and exports stimulate domestic investment, although the significance of these relationships is relatively weaker. This means that while economic growth and export activities do positively impact domestic investment in the short run, the effect is not as strong or as direct as the impact of domestic investment and exports on economic growth. The positive influence of economic growth on domestic investment can be attributed to increased business confidence and profitability during periods of economic expansion, encouraging firms to reinvest their earnings. Similarly, higher export levels can lead to greater capital inflows and improved financial conditions, which in turn can spur domestic investment. However, the relatively weaker significance suggests that other factors,

possibly including economic policies, market conditions, and external economic environments, also play a crucial role in determining the level of domestic investment.

**Table n°6.** Results of VECM models in the short run

VEC Granger Causality/Block Exogeneity Wald Tests			
Dependent variable: D(DLOG(Y))			
Excluded	Chi-sq	df	Prob.
D(DLOG(DI))	15.77935	2	0.0004
D(DLOG(X))	29.14358	2	0.0000
All	36.94183	4	0.0000
Dependent variable: D(DLOG(DI))			
Excluded	Chi-sq	df	Prob.
D(DLOG(Y))	5.831395	2	0.0542
D(DLOG(X))	4.656425	2	0.0975
All	5.982735	4	0.2004
Dependent variable: D(DLOG(X))			
Excluded	Chi-sq	df	Prob.
D(DLOG(Y))	20.58493	2	0.0000
D(DLOG(DI))	15.89570	2	0.0004
All	26.68279	4	0.0000

**Source:** Authors' calculations using EViews 12 software.

The analysis also highlights the synergistic effect of economic growth and domestic investment in fostering short-term export expansion. This finding underscores the importance of a vibrant domestic economy and robust investment climate for enhancing export performance. When the economy grows, it generally leads to better infrastructure, more efficient production processes, and enhanced competitiveness of domestic industries, all of which are vital for increasing exports. Likewise, domestic investment contributes to the development of export-oriented sectors by improving technological capabilities, expanding production capacities, and enhancing the quality of goods and services destined for international markets. The combined effect of economic growth and domestic investment creates a favorable environment for exports to flourish in the short term.

The short-term VECM results provide a detailed picture of the immediate interactions between economic growth, domestic investment, and exports. Domestic investment and exports emerge as key drivers of short-term economic growth, highlighting their critical role in stimulating economic activity. Although economic growth and exports also encourage domestic investment, this relationship is less pronounced, indicating the influence of additional factors. Finally, the joint contribution of economic growth and domestic investment to short-term export expansion emphasizes the importance of fostering a dynamic domestic economy and a supportive investment climate to boost export performance. These findings are essential for policymakers aiming to implement strategies that harness the short-term benefits of investment and export activities to stimulate overall economic growth.

## 5. Conclusions and recommendations

This research paper investigates the relationships between domestic investment, exports, and economic growth in Saudi Arabia from 2000 to 2021. Through rigorous cointegration and vector error correction model (VECM) analyses, several important findings have

emerged. Firstly, it is observed that neither domestic investment nor exports have a significant long-term impact on economic growth. This suggests that over an extended period, other factors beyond these two variables might play a more crucial role in driving the nation's economic development. It is imperative for policymakers to identify and focus on these other contributing factors to effectively sustain long-term economic growth. Secondly, the analysis indicates that long-term domestic investment does not significantly influence exports, and vice versa. This finding challenges the conventional notion that increased domestic investment directly boosts export performance. It suggests that in the context of Saudi Arabia, the relationship between these two variables is more complex and might be influenced by various external and internal factors, such as global market conditions, trade policies, and domestic economic structures. Despite the lack of significant long-term impacts, the research reveals positive long-term dynamics where economic growth and domestic investment positively influence exports over an extended period. An increase in economic growth and domestic investment is associated with a subsequent rise in exports. This implies that fostering a stable and growing domestic economy, alongside encouraging investments, can create a favorable environment for export activities to thrive in the long run. This highlights the importance of maintaining economic stability and promoting investment to enhance the country's export capabilities.

The short-term analysis provides additional insights. It is found that domestic investment and exports serve as causal factors for short-term economic growth. This indicates that, in the short run, increasing investments and export activities can lead to immediate improvements in economic performance. For instance, investment in infrastructure and production capacities can rapidly boost economic activity and job creation, while a rise in exports can increase foreign exchange earnings and stimulate related sectors. Furthermore, short-term relationships are identified where economic growth and exports stimulate domestic investment, albeit with relatively weaker significance. This suggests that while economic expansion and export growth do encourage investment, other factors also play a critical role in driving domestic investment decisions. Policymakers should consider these additional factors when designing strategies to stimulate investment. Lastly, the results highlight that economic growth and domestic investment jointly foster short-term export expansion. This underscores the synergistic effect of a vibrant domestic economy and a robust investment climate in enhancing export performance. By focusing on policies that promote economic stability and encourage investments, Saudi Arabia can boost its export sector in the short term.

The findings of this research suggest that while domestic investment and exports are crucial for short-term economic growth, their long-term impact on economic growth in Saudi Arabia is limited. Therefore, it is essential to investigate additional economic, political, and structural factors to better understand and enhance long-term economic growth. Policymakers should adopt a comprehensive approach that includes fostering economic stability, promoting investments, and identifying other key drivers of economic growth to achieve sustainable development.

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## Local resilience in the context of digital transition: development policy perspectives from Romania and Moldova

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**Abstract.** *The paper discusses the impact of digital transformation on the development of local resilience in Romania and Moldova, considering broadband infrastructure and ICT service exports. In connection with the findings, it should be noted that, for economic stability in Moldova, broadband expansion is extremely important, while in Romania, more benefits come from digital trade and technology-driven services. Policy incentives for broadband access, digital entrepreneurship, and regional digital ecosystems are necessary to support resilience. Customized strategies – infrastructure investments and innovation-driven policies for both countries – to enable sustainable economic development and adaptability within the digital era.*

**Keywords:** sustainable development, digital infrastructure, economic resilience, digital transformation, economic adaptability.

**JEL Classification:** O33, R11, L86, J21.

## Introduction

The shift to digital is profoundly transforming the world's economies—its effects most felt in developing markets like Romania and Moldova. According to Vial (2019: pp. 118-144), digital transformation contributes to strengthening economies through the development of e-commerce and digital infrastructure, which is considered the fundamental support for any economic activity. Dependency of economies on online applications requires robust digital legislation as well as infrastructure investment as a prerequisite for sustainable expansion and robustness (Verhoef et al., 2021: pp. 1-20). Economic resilience is the capacity of a region to face economic shocks and setbacks with digital infrastructure positioned at the heart of this (Martin & Sunley, 2015: pp. 1-42). Fast internet access, significant network growth, and broadband investment are all considered major local economies that promote flexible and stable conditions (Sutton et al., 2023: pp. 500-532). Both Romania and Moldova, which are undergoing major transformations in their digital systems, have new and rather special opportunities and challenges for each. The former benefits from EU-backed policies promoting digital expansion, while the latter suffers from infrastructure gaps that impede its full digital integration into the European space (Lungu et al., 2023: pp. 10-25).

The literature has put great emphasis on the investment in digital infrastructure as part of economic resilience. Evidence indicates that broadband penetration remarkably increases productivity and innovation, leading in the long run to steady income growth and more intense economic activity (Omrani et al., 2024: pp. 5030-5043). In Romania, high-speed internet is available to 90% of urban households, while the rural areas have lower connectivity due to lacking infrastructure (World Bank, 2023). Moldova has done a good job expanding digital access, but because only 65% of households in rural areas have broadband connections, there is still a significant digital divide (World Bank, 2022).

In Moldova, the public service digitization and broadband expansion initiatives have accelerated digital transformation through enhanced public services digitization and improved broadband connectivity. However, disparities remain, especially in rural areas, where reliable digital service access is a persistent problem (Lungu et al., 2023: pp. 30-45). In Romania, digital infrastructure development is part of overarching EU strategies, but rural broadband penetration remains a major barrier to digital inclusion at the national level (Bucea-Manea-Țoniș et al., 2022: pp. 1-20).

Economic resilience in the digital era is bolstered by investment in digital infrastructure both at the local and national levels. According to studies, economies having higher broadband penetration portray greater economic stability amid any kind of disruptions as digital tools support business continuity, business operations in a work-from-home setup, and e-services (Verhoef et al., 2021: pp. 10-25). It is a positive sign that Moldova is making efforts to widen digital infrastructure, but this only indicates partial progress and a need for further investment to ensure full economic participation in all regions of the country (Lungu et al., 2023: pp. 50-65). A fundamental difficulty for Romania and Moldova is the problem of bridging the digital divide between the urban and rural populations. While the cities have benefited from fast digital growth, the rural areas lag due to infrastructural deficiencies, and this situation impedes their economic potential (Omrani et al., 2024: pp. 5040-5055).

Only specific policy actions such as enlarged broadband networks and public-private partnerships can fill these divides and steer inclusive digital growth (Sutton et al., 2023: pp. 520-532). Inclusion of digital infrastructure in governance and economic planning will help optimize development strategies. Data-driven decision-making as facilitated by digital analytics enables governments to allocate resources efficiently and ensure that digital expansion aligns with economic priorities (Hess et al., 2020: pp. 12-18). Long-term investments in broadband expansion and fiber-optic networks will sustain economic growth in both countries (Verhoef et al., 2021: pp. 25-40).

This paper presents an assessment of the effects that digital infrastructure has on economic resilience in Romania and Moldova. It engages in a quantitative analysis of the correlation between gross domestic product per capita and broadband penetration. The results will offer information for policymakers striving to bolster digital policies and back up economic stability during the process of transition, which is predominantly digital.

### Literature review

The economic resilience factor has also taken new forms with the process of digital transition, especially for developing economies such as Romania and Moldova. Digital infrastructure is essential to ensure connectivity, particularly high-speed connectivity, enable digital services, and foster innovation. All these elements support the sustainability of economic growth (Vial, 2019: pp. 118-144). While both countries are undergoing their digital transformations, disparities in broadband expansion, digital access, and regional connectivity continue to play a significant role in shaping the effectiveness of digital policies in both countries (Verhoef et al., 2021: pp. 1-20). This section reviews available theoretical and empirical literature on digital transformation and economic resilience, focusing on the role of digital infrastructure in sustaining local economic stability in Romania and Moldova.

Economic resilience has been studied a lot at the level of regional and national economies. Martin and Sunley (2015: pp. 1-42) define regional economic resilience as the ability of an economy to endure economic shocks and recover quickly. Digital transformation is increasingly viewed as one of the major drivers of resilience, with higher investments in broadband and digital connectivity promoting economic flexibility as well as productivity and regional adaptability (Sutton et al., 2023: pp. 500-532). Strong digital infrastructure makes economies more resilient to financial and social shocks because digital connectivity supports business continuity during disruptions, e-commerce, and essential services (Hess et al., 2020: pp. 6-15). Another major facet of digital transformation revolves around upgrading high-speed broadband infrastructure. According to various stakeholders, broadband access is fundamental to economic productivity, innovation, and inclusion in that it gives businesses and citizens the capability to partake in the digital economy (Omrani et al., 2024: pp. 5030-5043). In Romania, high-speed broadband is available in over 90% of urban households, while the rural area remains under-provisioned, thereby hindering digital inclusion (World Bank, 2023). In Moldova, digital access has been improved through state-led initiatives, but more than 65% of rural households do not have proper

broadband internet access, which hinders their full participation in digital services (World Bank, 2022). According to the IMF Report (2020: pp. 15-30), low levels of digital infrastructure are among the predominant factors impeding economic growth for a majority of Eastern European countries and more so for non-EU member states such as Moldova.

The digital divide, parallel to the urban-rural economic divide, is a chronic impediment to economic resilience in both countries. While the metropolitan areas have experienced rapid digitization, rural regions lag due to low broadband penetration and investment in infrastructure insufficient to support high digitalization (Sutton et al., 2023: pp. 520-532). It limits economic participation in the hinterland and further sharpens economic inequalities. Directed government policies public-private investment are required to close this gap for inclusive economic growth and to take local economies along with them, rather leaving them behind (Omrani et al., 2024: pp. 5040-5055).

One of the most important aspects of public policy is that it profoundly influences digital transformation. It has been argued that effective policy frameworks should address broadening digital access while ensuring equitable availability across all strata and harmonizing the use of digital tools in economic planning (Verhoef et al., 2021: pp. 10-25). Romania has merged its digital policies with those of EU digital strategies, which have brought enormous investments in broadband infrastructure plus projects for regional inclusion in the digital world. The real problem, however, remains the enforcement of regulations, especially for connecting underdeveloped regions. This is where the Romanian Government still struggles due to its newly formulated Digital Transformation Strategy for 2023-2027, prioritizing the extension of digital infrastructures and improving internet access in rural areas (World Bank, 2023). Moldova, on the other hand, is behind even in laying down its digital policies and needs much more institutional support and investment strategies to push it into a proper digital economy faster (Lungu et al., 2023: pp. 50-65).

Empirical research underscores the economic paybacks of investing in digital infrastructure. Indeed, it has been established that greater broadband penetration is highly correlated with higher economic growth as well as resilience (Vial, 2019: pp. 118-144). In Romania, GDP per capita rose from 30% of the EU average in 1995 to 59% in 2016 mostly due to digital take-up and deeper integration into the European single market (World Bank, 2018). Remittances continue to play an important role in Moldova, with a share of 16.5% of GDP in 2023, thereby making economic diversification through digital expansion imperative policy such a priority (World Bank, 2022). Digital transformation can be viewed as a window through which this dependency can be lessened while at the same time creating sustainable models of economic growth.

The World Bank (2020: pp. 40-60) noted investment in digital infrastructure as one of the major economic drivers in Eastern Europe. Romania has benefited from EU funding under the 2021-2027 Cohesion Policy offering broadband expansion projects aimed at closing regional digital gaps (World Bank, 2023). Unlike Moldova, which does not have large-scale EU funding opportunities and where international development assistance is the only source to finance digital infrastructure projects (IMF, 2020: pp. 25-40), consistent funding is a major constraint that hinders Moldova from accelerating its digital transition at par with Romania.

In Romania and Moldova, the COVID-19 pandemic hastened digitalization, which revealed the importance of strong digital infrastructure. In Romania, digital banking services grew by 30% in 2020 and online government services registered a 40% increase in usage (World Bank, 2023). Emergency digital measures were implemented in Moldova, but due to the rural infrastructure shortcomings, most citizens could not access digital services effectively (World Bank, 2022). These trends have once again underlined how broadband infrastructure can be a lifeline for economic resilience in times of crisis.

In addition, the inclusion of digital infrastructure in governance and economic planning would help maximize national and regional development strategies. With big data analytics, digital technologies empower governments to allocate resources efficiently and design policies that address the economic imbalance (Hess et al., 2020: pp. 12-18). What will long-term investments in fiber-optic networks, 5G expansion, and making digital services accessible contribute to Romania and Moldova's sustainability of economic growth and resilience? (Verhoef et al., 2021: pp. 25-40).

Future studies should continue to examine the long-term effects of the investment in digital infrastructure on local and, respectively, national resilience. Although the studies in place prove that Romania and Moldova have much to gain from further digital development, what is actually needed now is an assessment of the sustainability and scalability of digital infrastructure projects in these two countries (Sutton et al., 2023: pp. 510-525). Closing the broadband gap, enhancing digital access to disadvantaged areas, and ensuring that the policies in the digital world align with economic development objectives are the three priorities that should be assumed by policymakers, as per (Bucea-Manea-Țoniș et al., 2022: pp. 15-30).

## Methodology

This paper uses a quantitative research method to look at the link between GDP per person and main signs of digital change in two developing countries—Romania and Moldova. As digital growth plays a bigger part in economic strength, this study wants to see how tech tools and the online market help with economic stability.

The model specifically determines how broadband penetration and IT service exports influence GDP per capita; thus, it gives a clear indication of how digital connectivity as well as the expansion of digital services quagmire economic growth. The choice of these variables comes from a broad range of literature related to digital transformation and economic resilience. Fixed broadband subscriptions can be regarded as one measure of the penetration of digital infrastructure, reflecting to what extent households and businesses can avail themselves of high-speed internet access-essential for productivity, innovation, and digital inclusion. Exports of IT services capture the economic effects of digitalization; they measure how well Romania and Moldova are integrating into the global digital economy, applying technology-enabled services and work-from-home opportunities. GDP per capita is used as the dependent variable, illustrating the country-by-country economic performance and resilience in terms of digital transformation for both Romania and Moldova.

To evaluate the role of digital infrastructure and digital economic activities in promoting economic stability and growth, within the concept of digital transition, is what this paper aims to achieve. Setting the stage for evidence-based policymaking, this analysis will help answer the question of whether, in Romania and Moldova, greater broadband expansion or a higher emphasis on the digital services sector would be more effective in boosting economic resilience.

Accordingly, the equation of the regression model is as follows:

$$Y=a+b_1X_1+b_2X_2+u \quad (1)$$

where:

Gross domestic product per capita (Y) is used as the dependent variable, representing economic resilience and overall economic performance. The independent variables include fixed broadband subscriptions ( $X_1$ ) which measure the dissemination of digital infrastructure and exports of IT services ( $X_2$ ) which capture the role of the digital economy in economic growth. These variables reflect how much digital connectivity and the expansion of technology-driven services contribute to national economic stability.

This model contains an intercept (a) and  $b_1$  and  $b_2$  which are the coefficients of regression that measure how much GDP per capita varies due to change in broadband penetration and IT service exports respectively. The term for error (u) includes all other unobserved factors that may affect the dependent variable.

It was sourced from the World Bank Database to ensure a homogeneous and internationally comparable dataset. This period 2014–2023 was deemed suitable for the purpose of trend analysis regarding digital transition and economic resilience. The study reviews three basic indicators annually to empirically assess the interaction between technological infrastructure, digital economic activity, and economic performance in reality.

After data gathering, the analysis was done using EViews. This application is famous among many for time-series econometric modeling and fits well for regression analysis, hypothesis testing, and diagnostic evaluations. The multifactorial regression model will allow a quantitative assessment of the relationship between digital transformation and economic resilience. Ordinary Least Squares (OLS) method of parameter estimation has been adopted to ensure the validity and reliability of the findings. Using these econometric techniques, the study tries to produce relevant policy insights about how digital infrastructure can contribute to building economic resilience in Romania and Moldova.

## Results and discussion

The following table (Table 1) includes data regarding the evolution of the gross domestic product per capita, the evolution of fixed broadband subscriptions and the value of ICT Service Exports in Moldova and Romania in the period 2014-2023.



**Table 1.** *GDP per Capita, Fixed Broadband Subscriptions, and ICT Service Exports in Moldova and Romania (2014–2023)*

Year	Moldova			Romania		
	GDP per capita (current US\$)	ICT Service Exports (BoP, current US\$)	Fixed broadband subscriptions	GDP per capita	ICT Service Exports (BoP, current US\$)	Fixed broadband subscriptions
2014	8643,064314	186000000	509000	20633,00931	3056184483	4020000
2015	9197,618382	162030000	534000	21630,4079	3033088350	4260000
2016	10325,84049	154900000	557000	23905,18822	3736652421	4450000
2017	11252,11355	175820000	584000	26943,36772	4538769870	4750000
2018	11868,19555	225460000	623000	29586,61687	5653482738	5090000
2019	13413,22329	257870000	671000	33638,6966	6256824613	5280000
2020	13527,44131	302950000	719000	34386,17739	7015995146	5680000
2021	15682,07033	401860000	762000	37698,35811	8252854113	6100000
2022	16381,30683	512160000	800000	42182,57281	9799361359	6370000
2023	17596,88342	629400000	841000	45658,66144	11049495224	6630000

**Source:** The World Bank, World Development Indicators.

Table 2 shows the results of the regression analysis which tested the relationship between GDP per capita, fixed broadband subscriptions, and ICT service exports in Moldova for the years 2014–2023. These findings offer useful insights into how digital transformation helps build economic resilience; they also note the different effects that broadband growth and digital services export have on economic development.

The major result of the study is the very strong positive link between broadband uptake and GDP per capita. The coefficient for broadband uptake is 0.0261 with a p-value of 0.0001, showing a really significant effect on economic growth. This finding means that more broadband access directly helps raise productivity, expand trade opportunities, and boost general economic stability in Moldova. Given this strong connection, putting money into broadband roads should keep staying at the top of the list for decision-makers to keep economic growth going and better digital inclusion.

On the other hand, ICT service exports do not have a statistically significant impact on GDP per capita. The coefficient for ICT service exports is  $-2.54E-08$  and its p-value is 0.9921, which means it has an insignificant and trivial impact on economic growth. This result indicates that despite digital services' increasing role globally, Moldova's ICT sector has not been strengthened enough to contribute significantly to the country's economic resilience. The outcome may be attributed to low global competitiveness among firms in Moldova's ICT sector insufficient workforce digital skills, and structural barriers within the ICT industry. Future policy efforts should orient towards strengthening digital service exports-in other words, enhancing skill development, providing incentives for digital entrepreneurship, and improving access to international markets.

The model as a whole is very robust and statistically significant. The R-squared value, at 0.986, means that 98.6% of the variation in GDP per capita is explained by broadband penetration and exports of ICT services. The F-statistic value, at 242.23, with an associated p-value of 0.000000, confirms that the model is highly significant. Digital transformation variables then, do explain economic trends in Moldova. Last, the Durbin-Watson statistic, at 2.53, suggests no serious problems with autocorrelation and serves to further enhance the reliability of the results.

**Table 2.** *Digital Transformation and Economic Resilience in Moldova*

Dependent Variable: GDP per capita  
(current US\$)  
Method: Least Squares  
Included observations: 10

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4434.414	1606.389	-2.760486	0.0281
ICT Service Exports (BoP, current US\$)	-2.54E-08	2.47E-06	-0.010298	0.9921
Fixed broadband subscriptions	0.026107	0.003453	7.560832	0.0001
R-squared	0.985757	Mean dependent var		12788.40
Adjusted R-squared	0.981687	S.D. dependent var		3067.516
S.E. of regression	415.1105	Akaike info criterion		15.13829
Sum squared resid	1206217.	Schwarz criterion		15.22907
Log likelihood	-72.69146	Hannan-Quinn criter.		15.03871
F-statistic	242.2303	Durbin-Watson stat		2.533568
Prob(F-statistic)	0.000000			

**Source:** Authors' own data processing in eViews, based on the data from Table 1

Table 3 shows the results of regression analysis which looks at GDP per capita, fixed broadband subscriptions, and ICT service exports in Romania between 2014–2023. Findings give some clues about how digital transformation helps build economic resilience, showing different ways broadband infrastructure and ICT services contribute to growth.

The analysis shows that exports of ICT services have a large positive effect on Romania's GDP per capita. The value for ICT service exports is 1.99E-06, with a p-value of 0.0263, which means that the link is statistically important. This indicates that growth in Romania's online services industry helps economic results, strengthening the part of ICT service exports as a main driver of economic rise. The findings point out the growing value of digital trade in Romania's economy, backing the idea that money spent in the ICT field, worker online skills, and tech innovation help a lot in boosting economic strength.

In contrast, fixed broadband subscriptions show no statistically significant impact on GDP per capita. With a coefficient of 0.003310 and a p-value of 0.1714, it can be inferred that broadband penetration by itself does not influence economic growth in Romania in a strong manner. These results contradict those findings in Moldova—in which broadband infrastructure exerted a strong impact on GDP per capita. Perhaps broadband penetration is already at an above-average level in Romania, and further access does not generate the same marginal returns to economic growth as it does in other countries with less developed digital infrastructure. It seems that the expanding digital economy in Romania is rather getting its additional value from the expansion of ICT services than from further broadband access.

The overall model is very reliable and statistically significant. An R-squared value of 0.993 means that 99.3% of variation in GDP per capita is explained by independent variables. The F-statistic value of 471.0884 and its associated p-value of 0.000000 confirm that the model is highly significant which implies digital transformation factors core role in the explanation of economic trends in Romania. Another indication of result validity comes from the Durbin-Watson statistic value of 2.18, it shows that there is no serious problem with autocorrelation.

**Table 3.** *Digital Transformation and Economic Resilience in Romania*

Dependent Variable: GDP per capita  
(current US\$)  
Method: Least Squares  
Included observations: 10

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1807.615	7093.001	0.254845	0.8062
ICT Service Exports (BoP, current US\$)	1.99E-06	7.08E-07	2.806542	0.0263
Fixed broadband subscriptions	0.003310	0.002173	1.523622	0.1714
R-squared	0.992625	Mean dependent var		31625.90
Adjusted R-squared	0.990518	S.D. dependent var		8585.085
S.E. of regression	835.9730	Akaike info criterion		16.53839
Sum squared resid	4891956.	Schwarz criterion		16.62917
Log likelihood	-79.69197	Hannan-Quinn criter.		16.43881
F-statistic	471.0884	Durbin-Watson stat		2.182701
Prob(F-statistic)	0.000000			

**Source:** Authors' own data processing in eViews, based on the data from Table 1.

Moldova and Romania have some very particular broadband infrastructure and ICT service exports contributions to GDP per capita as a result of the analysis of digital transformation and economic resilience. For fixed broadband subscriptions, in Moldova, the effect is significantly positive on economic growth, with a strong statistical relationship implying that increase in broadband penetration directly supports increase in productivity and expansion of business. The exports of ICT services do not show a significant effect, indicating that the digital economy in Moldova does not yet develop enough to drive substantial economic gains. This highlights the necessity for constant investment in broadband infrastructure as the primary strategy to enhance economic resilience for Moldova also long-term policies directed towards strengthening the ICT sector.

Romania, in contrast, is more resilient economically due to exports of ICT services rather than broadband infrastructure. It reveals that ICT service exports have a statistically significant positive correlation with GDP per capita, while broadband subscriptions do not bear any significant impact. This fact evidences that Romania has developed its digital

economy beyond the stage of ensuring basic infrastructure, as higher economic value is obtained from digital trade and technology-based services. Therefore, policies in Romania should focus more on increasing ICT service exports, fostering digital entrepreneurship, and improving workforce skills in using digital tools instead of enhancing broadband. These represent the differences between Moldova and Romania, proving that their stages of digital transition are different and that country-specific policy strategies are needed to tap the full economic benefits of digital transformation.

## Conclusions

One of the major problems that lingers over Moldova is the digital divide, with rural areas being most affected due to limited broadband presence. This scenario does not allow them to participate in economic activities and express themselves creatively. Both targeted infrastructure investment and public-private partnership can be channeled toward this effort to make locals more resilient by enhancing digital inclusion. In Romania, where broadband access is already pervasive, further investment should be directed toward strengthening digital entrepreneurship and innovation. Strong digital entrepreneurship and innovation make the local economy adaptable and competitive.

Policies at the community level regarding broadband access, developing digital skills, and supporting ICT entrepreneurship would create local resilience in Moldova. Providing startup financial incentives, improving regulatory frameworks, and ensuring equitable digital access for local business empowerment would foster inclusive economic growth. Decentralized digital hubs in rural areas would minimize the economic divide and stimulate regional self-sufficiency in ICT entrepreneurship.

In contrast, Romania should create policy incentives that enhance competitiveness in the global digital market while ensuring local economies benefit from it. Investment in high-value digital services such as artificial intelligence, software development, and fintech would ensure long-term resilience at the local level. Strengthened collaboration between academia, industry, and regional policymakers would not only support the sustainability of progress in the digital field but also economic adaptability at the local level.

Different strategies are needed by both countries to capitalize on the opportunities offered by digital transformation and local resilience. While in Moldova, policy incentives for inclusive digital growth fill the infrastructure gap, in Romania, the existing digital assets are leveraged through policies promoting innovation, trade, and regional digital ecosystems. With such targeted policies, the two countries would not only be able to strengthen their economic resilience but also attain sustainable development in the digital era.

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## Customs unions and trade spillovers: from bilateral agreements to multilateral impact

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**Abstract.** *This paper considers a general equilibrium model of trade to examine how a move from bilateral trade within a customs union to multilateral free trade affects skilled-unskilled wage inequality within the customs union. It also shows the spillover effects of a reduction in common tariffs on countries outside the union. It is interesting to see that increased liberalization raises skilled-unskilled wage inequality under reasonable conditions within the customs union. Moreover, for the country outside the customs union, export of intermediate product to the customs union rises, accompanied by an increase in income of the capitalists and the wage earners and a decrease in income of the landlords. Also, employment and output in the import competing sector falls while the exportable sector witnesses an increase in employment and output for the country outside the customs union. These results have interesting political-economic implications.*

**Keywords:** customs unions, skilled labour, unskilled wages, protectionism, liberalization, intermediate goods.

**JEL Classification:** F1, F11, F13, F16, F20, D58.

## 1. Introduction

The World Trade Organization (WTO) Secretariat, around 26th August 2020, had published a new information note discussing how, in the wake of the COVID-19 pandemic and subsequent lockdowns imposed worldwide, strict mobility barriers and temporary border closures have heavily affected international trade in goods and services, in addition to affecting the global tourism industry (which has performed its worst since 1950) and educational services (with many international educational institutions facing a drastic drop in international student enrollment, sometimes as much as 50 to 70 per cent), as well as various manufacturing value chains. Such restricted cross-border movements have led to increased transaction and transportation costs, but have eventually been followed by policies that are somewhat less strict, such as allowing through “essential” foreign workers, or making way for quarantine free “travel bubbles” among trading partners. The paper stresses on the role that international co-operations play in minimizing the potential economic impact of transnational mobility restrictions, which also have huge cross-border spillover effects, coupled with scaling down of production and consumption across the globe. So far, 80 countries and separate customs territories, including 46 WTO members (72 if European Union (EU) member states are counted individually) and eight non-WTO members, have introduced several temporary prohibitory measures on exports owing to the ongoing pandemic. At least two members have already removed some of these restrictions. Though Article XI of the General Agreement on Tariffs and Trade (GATT) 1994 prohibits export bans and restrictions, members are allowed to temporarily apply such measures to meet critical food shortage or shortage of other essential products. More general exceptions to WTO rules are used to justify trade restrictions provided that they do not arbitrarily or purposefully discriminate against certain countries. When major exporters restrict their exports, domestic prices for the exportable goods are lowered in the short run, but there is a significant cost involved. Countries which relied on imports of these goods, and are unable to domestically produce the same, are hit hard. It is a two-pronged knife, while lower domestic prices reduce the incentive to produce the good domestically, higher foreign demands and hence higher foreign prices provide an impetus to smuggle the good out of the exporting country, both of which are likely to reduce domestic availability of the good. Trade restrictions may also give rise to domino effects. In the absence of secure access to essential goods, some countries may decide to substitute imports with domestic production, even at much higher prices and at the risk of lowered supply. This could have adverse long-term effects on the countries which previously exported that good.

Viani (2019) simulates econometric models to show that tariff measures undertaken by the USA have had relatively moderate direct effects on the global economy and on EU member countries, though it has led to massive escalations in USA-China trade tensions. However, the simulations warned of deteriorating trade effects that could be brought about by a fall in business confidence and unfavourable international financial markets, which indeed



seem to be the case post the COVID-crisis. Marjit and Oladi (2018) illustrates that, for an intermediate good that uses unskilled labour, increased protectionism actually reduces unskilled wages. Saggi and Yildiz (2010) assesses the relative merits of bilateralism vs purely multilateral free trade and come to the conclusion that, in a perfectly symmetric world, global free trade is the sole stable equilibrium irrespective of whether individual countries are free to enter into bilateral trade agreements or not. However, they also show that, if countries have asymmetric endowment levels, then there exist circumstances under which free trade is a stable equilibrium if and only if countries have the choice to willingly forge bilateral trade ties, and these results hold even under politically motivated government regimes where producer surplus and tariff revenues are valued more than consumer surplus. Stevens (2005) studies policy changes in the WTO and the bilateral policies of the Quad (Canada, the EU, Japan and the USA), particularly the Economic Partnership Agreements that sub-Saharan Africa needs to negotiate with the EU and changes in Europe's Common Agricultural Policy (CAP). Jorzik and Mueller-Langer (2013) have studied the endogenous network formation of bilateral and multilateral trade agreements and have introduced the equilibrium concept of multilateral stability, under a multi-country setting with a firm in each country that produces a homogeneous good and functions as a Cournot oligopolist in each market. It is found that under endogenous tariffs, the WTO/GATT regime itself, together with a bilateral preferential trade agreement (PTA) is multilaterally stable. The existence of the WTO is found to be necessary for the stability of the trading system and the formation of PTAs increases countries' incentives for multilateral tariff reduction.

The purpose of this paper is to examine the spillover effects of a trade policy change within the customs union on countries both within and outside the customs union. Specifically, in this paper we have tried to examine the impact of a tariff cut on imports of intermediates by the customs union, on countries within and outside the union. Such a work implies the spillover effects of a movement from bilateral to multilateral free trade. There is a dearth of literature on general equilibrium trade models to capture this particular issue, especially the spillover effects of such a change. The works mentioned earlier are either general equilibrium models that focus on the effects of tariff cut on wage inequality or a comparison of the merits of bilateral trade vis-à-vis those of multilateral trade. However, in neither of these models the issue of customs union and the spillover effects of changes from bilateral to multilateral trade due to tariff cut have been considered. The study is motivated by the fact that although the WTO prescribes free trade, the current global scenario considers issues related to neo-protectionism on one hand and breaking of customs union on the other hand in the form of quitting of Great Britain from the European Union (BREXIT). Our paper throws light on the issues related to lower protectionism within the union and its spillover effects. Thus our paper can be considered to be an important guide for the policy makers who are interested in contemporary policy issues for the global economy.

The paper is organized as follows. Section 2 develops the model and discusses the results. Section 3 shows comparative statics, and Section 4 summarizes the conclusions.

## 2. The Model with Custom Unions

We consider 3 small open economies, namely,  $A$ ,  $B$  and  $C$  with four traded goods, three final goods denoted by  $X$ ,  $Y$  and  $V$ , and an intermediate good denoted by  $M$ . Countries  $A$  and  $B$  form a customs union and are engaged in bilateral trade amongst themselves in the following manner. Country  $A$  exports good  $X$  to country  $B$  and country  $B$  exports good  $Y$  to country  $A$ , without imposing any tariff on their respective imports. Furthermore, both countries  $A$  and  $B$  import an intermediate input  $M$  from country  $C$ , which is outside the customs union. A common tariff, denoted by  $t$ , protects the import competing sector in both countries  $A$  and  $B$ . Both the countries within the customs union agree to accept the world price and the country outside the union is also assumed to be a price taker and accepts the world price.

Country  $C$  exports its product  $M$  to countries  $A$  and  $B$  and imports a product  $V$  from the rest of the world, which is considered to be exogenous. Goods  $X$  and  $Y$  are also produced by country  $C$ .

We further assume that sector  $X$  uses skilled labour  $S$  and the intermediate product  $M$  as inputs, while sector  $Y$  uses unskilled labour  $L$  and capital  $K$  as inputs. The intermediate sector  $M$  uses unskilled labour  $L$  and capital  $K$  to produce its output. Here  $L$  and  $K$  are perfectly mobile between sectors  $Y$  and  $M$ , while  $S$  is specific to sector  $X$ . Also, it is assumed that good  $Y$  is labour intensive while commodity  $M$  is capital intensive. Commodity  $V$  is produced using unskilled labour  $L$  and a second type of capital, say, land, denoted by  $R$ . Hence,  $R$  is a specific factor for sector  $V$ .

All production functions exhibit constant returns to scale and other standard neoclassical properties. It is also assumed that all markets are perfectly competitive and all factors of production are fully employed. The small open economy assumption implies that prices are exogenous, and they are further normalized to unity for the sake of mathematical ease. Hence, we have  $P_M = (1 + t)P_M^* = 1 + t$ , where  $P_M$  is the per unit domestic price of commodity  $M$  in countries  $A$  and  $B$ , inclusive of tariff and  $P_M^*$  is the world price of commodity  $M$ , normalized to one.

### 2.1. The General Equilibrium

#### 2.1.1. Commodity and Factor Markets in Country A

The competitive equilibrium conditions in country  $A$  for the markets for the three commodities  $X$ ,  $Y$  and  $M$  are given by the following equations:

$$w_S a_{SX}^A + (1+t)a_{MX}^A = 1 \quad (1)$$

$$w a_{LY}^A + r a_{KY}^A = 1 \quad (2)$$

$$w a_{LM}^A + r a_{KM}^A = 1+t \quad (3)$$

where  $a^k_{ij}$  is the per unit requirement of factor  $i$  in sector  $j$  for country  $k$ , for  $i = S, L, K, M$ ;  $j = X, Y, M$  and  $k = A, B$ , whenever factor  $i$  is used in the production of output in sector  $j$ . Here,  $k = A$ . Also,  $w_S, w, r$  and  $t$  represent, respectively, the skilled wage, unskilled wage, rental rate of capital and the tariff imposed by the customs union on the intermediate input  $M$ . Prices of goods  $X$  and  $Y$ , that is,  $P_X$  and  $P_Y$  are assumed to be equal to one. Let  $T = 1 + t$ .

Full employment of all factors of production, namely,  $S, L, K$  and  $M$  implies that:

$$a_{SX}^A X^A = S^A \quad (4)$$

$$a_{LY}^A Y^A + a_{LM}^A M^A = L^A \quad (5)$$

$$a_{KY}^A Y^A + a_{KM}^A M^A = K^A \quad (6)$$

$$a_{MX}^A X^A = M^A + M^{*A'} \quad (7)$$

where, for country  $A$ ,  $S^A, L^A, K^A$  and  $M^{*A'}$  denote the stocks of skilled labour, unskilled labour, capital and the import of intermediate good  $M$ , respectively.  $X^A, Y^A$  and  $M^A$  denote the outputs of goods  $X, Y$  and  $M$ , respectively, by country  $A$ .

Our seven endogenous variables,  $X^A, Y^A, M^A, M^{*A'}, w_S, w$  and  $r$  can be determined from equations (1)-(7). Decomposability property holds for this general equilibrium structure, since factor prices and outputs are determined independently of each other for all countries.

### 2.1.2. Commodity and Factor Markets in Country B

Similarly, for country  $B$ , we have the competitive equilibrium conditions given by:

$$w_S a_{SX}^B + (1+t)a_{MX}^B = 1 \quad (8)$$

$$w a_{LY}^B + r a_{KY}^B = 1 \quad (9)$$

$$w a_{LM}^B + r a_{KM}^B = 1+t \quad (10)$$

Full employment of all factors of production in country  $B$  implies:

$$a_{SX}^B X^B = S^B \quad (11)$$

$$a_{LY}^B Y^B + a_{LM}^B M^B = L^B \quad (12)$$

$$a_{KY}^B Y^B + a_{KM}^B M^B = K^B \quad (13)$$

$$a_{MX}^B X^B = M^B + M^{*B'} \quad (14)$$

where, for country  $B$ ,  $S^B$ ,  $L^B$ ,  $K^B$  and  $M^{*B'}$  denote the stocks of skilled labour, unskilled labour, capital and the import of intermediate good  $M$ , respectively.  $X^B$ ,  $Y^B$  and  $M^B$  denote the outputs of goods  $X$ ,  $Y$  and  $M$ , respectively, by country  $B$ .

As in the case of country  $A$ , for country  $B$ , the seven endogenous variables, namely,  $X^B$ ,  $Y^B$ ,  $M^B$ ,  $M^{*B'}$ ,  $w_S$ ,  $w$  and  $r$  can be determined from equations (8)-(14).

Returns to the various factors of production in Country  $C$  are different from those in countries  $A$  and  $B$ , since country  $C$  is not a member of the customs union. Let  $w^*$ ,  $r_K^*$  and  $r_R^*$  denote the returns on unskilled labour, capital and land, respectively, in country  $C$ . Let  $M^*$  denote the total production of good  $M$  by country  $C$ .

We have, export of product  $M$  by country  $C$  = Import of product  $M$  by countries  $A$  and  $B$   
 $=M^{*'} = M^{*A'} + M^{*B'}$

Let  $P_M^*$  and  $P_V^*$  denote the world prices of commodities  $M$  and  $V$ . It is assumed that these prices are normalized to unity, to facilitate ease of calculation. Further, let  $V^*$  represent the output of good  $V$  by country  $C$  while  $L^*$ ,  $K^*$  and  $R^*$  denotes the stocks of unskilled labour, capital and land respectively, in country  $C$ .

### 2.1.3. Commodity and Factor Markets in Country C

The competitive equilibrium conditions in the markets for commodities  $M$  and  $V$  in country  $C$  are given by:

$$w^* a_{LM}^* + r_K^* a_{KM}^* = P_M^* \quad (15)$$

$$w^* a_{LV}^* + r_R^* a_{RV}^* = P_V^* \quad (16)$$

where  $a_{ij}^*$  denotes the per unit requirement of input  $i$  by sector  $j$  in country  $C$ . Here,  $i = L, K, R$  and  $j = M, V$ .

Full employment of all factors of production implies:

$$a_{LM}^* M^* + a_{LV}^* V^* = L^* \quad (17)$$

$$a_{KM}^* M^* = K^* \quad (18)$$

$$a_{RV}^* V^* = R^* \quad (19)$$

The five endogenous variables for country  $C$ , namely,  $w^*$ ,  $r_K^*$ ,  $r_R^*$ ,  $M^*$  and  $V^*$  can be determined from equations (15)-(19).

## 3. Comparative Statics and Results

We now proceed to analyze the effects of a decrease in the tariff rate on factor prices in country  $A$ . All the results obtained hold true for country  $B$  as well, by virtue of symmetry.

### 3.1. Effect of Tariff Cut in Country A within Customs Union

#### 3.1.1. Impact of Tariff Cut on Input Returns and Size of the Sectors

We now examine the effects of a tariff cut for the two countries within the customs union. Using equations (1) to (7) we get the following expression,

$$\left. \begin{array}{l} \left(\frac{\hat{W}}{\hat{t}}\right) < 0; \left(\frac{\hat{W}_S}{\hat{t}}\right) < 0 \\ \left(\frac{\hat{Y}}{\hat{t}}\right) < 0; \left(\frac{\hat{M}}{\hat{t}}\right) > 0; \left(\frac{\hat{X}}{\hat{t}}\right) < 0 \end{array} \right\} \quad (A)$$

For a tariff cut in the case of country A, we find from equation (1) that for given international price, such a tariff cut causes an increase in  $w_s$ . Again from equations (2) and (3) we find that our model for country A constitutes a Heckscher-Ohlin nugget within a hybrid set up. Hence a tariff cut creates a Stolper-Samuelson effect which causes rate of return on capital to fall and the unskilled wage rate to increase. The reason behind this is that sector M is more capital-intensive in physical and value terms than sector Y. We have already mentioned earlier that whatever is true for country A is also true for country B and hence we are not repeating the arguments for each of the two countries. It can be argued that as a reduction in tariff  $t$  (and hence a reduction in  $T$ ) causes an increase in unskilled wage rate, it results in a fall in the per-unit unskilled labour requirement of sectors Y and M. This would mean an increase in the effective supply of unskilled labour in the economy. Following Rybczynski type effect, we find that such a situation would lead to an increase in the output of the labour intensive good Y and a fall in the output of the capital intensive good M. Intuitively, it can also be argued that for country A, as  $T$  falls, skilled wages  $w_S$  rise, leading to a fall in the per unit labour requirement in the production of good X, which results in an increase in the output of good X if all factors of production are considered to be fully employed.

**Remarks 1:** *The adaptation of tariff cut by a representative country within a Customs Union leads to an expansion of sectors producing final goods, while intermediate good producing sector faces a reduction in its size of production.*

#### 3.1.2. Impact of Tariff Cut on Skilled-Unskilled Wage Inequality

We can also determine the direction of movement of skilled – unskilled wage inequality as a result of this tariff reduction. Here, a tariff cut causes increase in the levels of both skilled and unskilled wage rate and it can easily be checked that

$$\frac{(\hat{w}_S - \hat{w})}{\hat{T}} = \frac{1}{|\theta|} [\theta_{KY}^A - \theta_{MX}^A] < 0 \text{ if } \theta_{MX}^A > \theta_{KY}^A \quad (20)$$

The value share of  $i^{\text{th}}$  factor in  $j^{\text{th}}$  sector is given by  $\theta_{ij}$ . We assume  $\frac{\theta_{KM}}{\theta_{LM}} > \frac{\theta_{KY}}{\theta_{LY}}$ , implying sector M is more capital-intensive in value terms than sector Y so that  $|\theta| = \theta_{KM}^A \theta_{LY}^A - \theta_{KY}^A \theta_{LM}^A \Rightarrow |\theta| > 0$ .

**Remarks 2:** *The adaptation of tariff cuts by a representative country within a Customs Union leads to a contraction in the wage gap.*

### 3.2. Effects of Tariff Cut on the import of intermediate good by Country A

We now look into how a reduction in tariff affects the import of the intermediate good by country A. From Equation (7), using ‘hat algebra’ ( $\hat{x} = \frac{dx}{x}$ ) we get:

$$\hat{a}_{MX}^A + \hat{X}^A = \delta \hat{M}^A + (1 - \delta) \hat{M}^{*A'} \quad (7.1)$$

where  $\delta = \frac{M^A}{M^A + M^{*A'}} > 0$  and  $(1 - \delta) = \frac{M^{*A'}}{M^A + M^{*A'}} > 0$

From equation (7.1) we get

$$(1 - \delta) \frac{\hat{M}^{*A'}}{\hat{T}} = \frac{\hat{a}_{MX}^A}{\hat{T}} + \frac{\hat{X}^A}{\hat{T}} - \delta \frac{\hat{M}^A}{\hat{T}} \quad (7.2)$$

where  $T = 1 + t$  and  $\hat{T} = \frac{dt}{1+t} = \alpha \hat{t}$  given  $\alpha = \frac{t}{(1+t)}$

After some routine algebra (shown in the Appendix) we get

$$\frac{\hat{M}^{*A'}}{\hat{T}} = \frac{1}{(1-\delta)} \left[ -\delta \frac{(\lambda_{KY}^A \gamma_L + \lambda_{LY}^A \gamma_K)}{|\lambda||\theta|} - \frac{\sigma_X^A}{\theta_{SX}^A} \right] < 0 \quad (7.3)$$

where the physical shares of labour and capital in country A are given by  $\lambda_{LY}^A = \frac{a_{LY}^A \gamma^A}{L^A} > 0$  and  $\lambda_{KY}^A = \frac{a_{KY}^A \gamma^A}{K^A} > 0$ . We consider  $\sigma_j^k$  as the elasticity of substitution between the two factors of production used by sector  $j$  in country  $k$ , where  $j = X, Y, M$  and  $k = A, B$ . By definition, we always have  $\sigma_j^k > 0$ .

We also have

$$\gamma_L = (\lambda_{LM}^A \sigma_M^A \theta_{KM}^A + \lambda_{LY}^A \sigma_Y^A \theta_{KY}^A) > 0 \text{ and}$$

$$\gamma_K = (\lambda_{KM}^A \sigma_M^A \theta_{LM}^A + \lambda_{KY}^A \sigma_Y^A \theta_{LY}^A) > 0$$

$$\text{Finally we have } |\lambda| = (\lambda_{KM}^A \lambda_{LY}^A - \lambda_{KY}^A \lambda_{LM}^A)$$

As sector  $M$  is more capital-intensive in physical and value terms than sector  $Y$ , we have  $|\lambda| > 0$  and  $|\theta| > 0$ .

We now consider the intuition behind the result. A fall in tariff would result in a fall in the price of the imported intermediate good for the countries within the union. This in turn would lead to an increased demand for and an increase in import of the intermediate good by the customs union. It is to be noted that fall in the tariff rate causes an increase in skilled wage rate and it causes an increase in  $a_{MX}$  in both the countries within the customs union. We have also shown earlier that a fall in the tariff rate leads to an increase in output of

sector  $X$  in both the countries within the customs union. Algebraically we can specify it as<sup>(1)</sup>

$$\frac{\hat{X}^A}{\hat{T}} = -\sigma_X^A \frac{\theta_{MX}^A}{\theta_{SX}^A} < 0 \quad (21)$$

It has also been shown that a fall in the tariff rate causes a reduction in output of sector  $M$  for both the countries as mentioned earlier. Thus algebraically we have

$$\frac{\hat{M}^A}{\hat{T}} = \frac{(\lambda_{KY}^A \gamma_L + \lambda_{LY}^A \gamma_K)}{|\lambda| |\theta|} > 0 \quad (22)$$

So, we conclude that a reduction in tariff  $t$  (and hence, a fall in  $T$ ) leads to a rise in the import of the intermediate good  $M$  by the countries within the customs union.

**Remarks 3:** *A reduction in tariffs leads to an increase in the import of intermediate goods by countries within the customs union.*

### 3.3. Effects of Tariff Cut on the Import Share of Countries within the Customs Union

We next examine the effect of a decrease in tariff  $t$  on the import share of countries within the customs union. Let the total import of the intermediate good  $M$  by countries  $A$  and  $B$  be represented by  $M^{*I}$ .

$$\text{So, } M^{*I} = M^{*A'} + M^{*B'} \quad (23)$$

Let  $\alpha$  and  $(1 - \alpha)$  denote the import share out of total imports, for country  $A$  and country  $B$  respectively.

$$\text{Hence, } \alpha = \frac{M^{*A'}}{M^{*I}} \text{ and } (1 - \alpha) = \frac{M^{*B'}}{M^{*I}}$$

We thus have

$$\hat{\alpha} = \hat{M}^{*A'} - \hat{M}^{*I} \quad (24)$$

$$\text{If } \hat{\alpha} > 0 \Rightarrow \hat{M}^{*A'} > \hat{M}^{*I}$$

From equation (23) we get

$$\hat{M}^{*I} = \alpha \hat{M}^{*A'} + (1 - \alpha) \hat{M}^{*B'} \text{ which implies}$$

$$\hat{M}^{*A'} = \frac{\hat{M}^{*I} - (1 - \alpha) \hat{M}^{*B'}}{\alpha} \quad (25)$$

If  $\hat{\alpha} > 0$ , from equation (24) we get

$$\hat{M}^{*A'} = \frac{\hat{M}^{*I} - (1 - \alpha) \hat{M}^{*B'}}{\alpha} > \hat{M}^{*I} \Rightarrow \hat{M}^{*I} > \hat{M}^{*B'}$$

Hence we have  $\hat{M}^{*A'} > \hat{M}^{*I} > \hat{M}^{*B'} > 0$

Now, given that  $\hat{T} < 0$  it is implied that  $\frac{\hat{M}^{*A'}}{\hat{T}} < \frac{\hat{M}^{*I}}{\hat{T}} < \frac{\hat{M}^{*B'}}{\hat{T}} < 0$

Under the assumption of  $\hat{\alpha} > 0$ , we have  $\frac{\hat{\alpha}}{\hat{T}} < 0$  and  $\frac{\hat{\beta}}{\hat{T}} > 0$  where  $\beta = (1 - \alpha)$

The results will be exactly opposite if we assume that  $\hat{\alpha} < 0$ .

Therefore, we conclude that the effects of a reduction in tariff  $t$  (leading to a fall in  $T$ ) by the customs union, depends crucially on the direction of movement of the share of imports (out of total imports of the customs union) of the two countries. It determines the direction of movement of the individual volume of imports of the two countries and also the total volume of imports of the customs union. In particular, if the share of imports of country  $A$  out of total import of the customs union increases then the volume of imports of both the countries within the union will increase and in terms of ranking the increase in volume of imports of country  $A$  is the highest, the total increase in imports of the customs union is the second and the increase in volume of imports of country  $B$  is the least. All the results obtained so far allow us to make the following proposition:

**Proposition 1:** *A reduction in tariff on imported intermediate input for the member countries within a customs union results in an increase in skilled-unskilled wage inequality if the value of capital share of commodity produced by sector  $Y$  is less than the value of intermediate input share of commodity produced by sector  $X$ . Such a policy increases the volume of imports of both the countries within the customs union and its ranking depends crucially on the impact on share of import of the two countries as a result of tariff cut.*

**Proof of Proposition 1:** See the discussion above

QED

From the above proposition we find that when the share of imports out of total imports of country  $A$  increases, its volume of imports increases at the fastest rate. The rate of increase in the volume of imports of country  $B$  is the lowest and the rate of increase in the volume of imports of the customs union as a whole is moderate.

### 3.4. Spillover Effects of Tariff Cut in Country $A$ within Customs Union

We now consider the spillover effects of a tariff cut on a country which is outside the union and for this we consider country  $C$ . It has been shown earlier that  $\frac{\hat{M}^{*A'}}{\hat{T}} < 0$  and  $\frac{\hat{M}^{*B'}}{\hat{T}} < 0$ , i.e. both  $M^{*A'}$  and  $M^{*B'}$  rise as  $T$  falls. Since  $M^{*I} = M^{*A'} + M^{*B'}$ , hence total exports of the intermediate product by country  $C$ , i.e.  $M^{*I}$  also increases as  $T$  falls, which implies  $\frac{\hat{M}^{*I}}{\hat{T}} < 0$ . Increase in production of exports causes a shift in the demand for exports of country  $C$  in the world market which causes an increase in world price of exports in country  $C$ . Thus, in country  $C$  there is an increase in  $P_M^*$  and no increase in  $P_V^*$  so that there



is an improvement in the terms of trade. The model for country  $C$ , as shown by equations (15) to (19), is a Jones (1971) type sector-specific model and hence the standard results of Jones (1971) are valid here. We thus consider the price magnification effect of Jones (1971) model where we find that the returns to the sector-specific factors are radically affected and the returns to the mobile factors are moderately affected. Hence we have

$$\hat{r}_K^* > \hat{P}_M^* > \hat{w}^* > 0 > \hat{r}_R^* \quad (26)$$

Equation (26) is the price magnification effect for country  $C$ , when there is a reduction in tariff  $t$ . It implies that a tariff cut by a customs union leads to an increase in the income of the capitalists and workers, and a decrease in the income of the landlords, for the country outside the union.

Intuitively, one can argue that a fall in tariff leads to an increase in the rental rate of capital  $K$ , therefore, the per unit requirement of capital  $K$  in sector  $M$  falls and full employment of capital in terms of equation (18) implies that  $M^*$  must rise since total stock of capital  $K^*$  is fixed. Similarly a fall in tariff leads to a decrease in the rental rate of capital of type  $R^*$ , therefore, the per unit requirement of capital of type  $R^*$  in sector  $V$  rises as a result of a tariff cut. Assuming that capital  $R$  is fully employed, Equation (19) implies that  $V^*$  must fall since total stock of capital  $R^*$  is fixed. Here, though the return to the mobile factor labour increases, its increase is less than the increase in the rate of return on capital used in sector  $M$ , by the price magnification effect. Hence the wage rental ratio in this sector falls and the unit labor requirement for sector  $M$  increases. The opposite happens in case of sector  $V$ . As already explained, output of sector  $M$  increases and output of sector  $V$  falls due to tariff cut and hence employment in sector  $M$  increases and employment in sector  $V$  falls. This implies that for the country outside the customs union, employment in the exportable sector increases and employment in the import competing sector falls as a result of a tariff cut by the union. All the above results together lead us to put forth the following proposition:

**Proposition 2:** *For a country outside a customs union which exports an intermediate input to the union, a move from bilateral trade to multilateral free trade through a reduction in tariff by the union leads to an increase in income of the capitalists and the workers, and a decrease in income of the landlords. It also leads to an increase in output and employment of the exportable sector and a decrease in output and employment of the import competing sector.*

**Proof of Proposition 2:** See the discussion above.

QED

### 3. Concluding Remarks

We have considered in this paper a three-country, three-commodity general equilibrium model with a sector specific factor of production, where two of the countries form a customs union and impose a common tariff on the import of an intermediate input from the third country outside the customs union. In this paper we have shown the spillover effects of a tariff cut pertaining to the import of the union, within and outside the union. Within the union, we find that there is an increase in wage inequality under reasonable conditions as a result of such a tariff cut. We also find that there is an increase in imports of the countries within the union. In the country outside the customs union, a move from bilateral trade to multilateral free trade leads to an increase in the income of the capitalists and the workers, accompanied by a decrease in the income of the landlords. Furthermore, the output and employment of the exportable sector rises while the output and employment of the import competing sector, which uses land as a factor of production, falls.

These results have interesting political-economic implications. With the USA adopting ever stringent protectionist measures and the escalating US-China trade war, there is a growing global concern surrounding protectionism issues. Though it had been earlier agreed upon by WTO member countries that multilateral trade is better than bilateral or plurilateral trade agreements, but our results indicate that it might be in the vested interest of landowners to run a protectionist lobby. When it comes to whether a country outside a customs union would support a tariff cut or not, it then boils down to which group in the said country has more lobbying power, the landlords or the capitalists and workers as a united front.

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#### Note

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- <sup>(1)</sup> Here we show the algebraic results only for country *A*. As the results are symmetric they are also valid for country *B*.

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## Annex

We look at the impact of a tariff cut on the import of intermediate good  $M$  by country  $A$ .

Equation (7) says

$$\begin{aligned} a_{MX}^A X^A &= M^A + M^{*A'} \\ \Rightarrow \frac{\widehat{M}^{*A'}}{\widehat{T}} &= \frac{1}{(1-\delta)} \left[ \frac{\widehat{a_{MX}^A}}{\widehat{T}} + \frac{\widehat{X^A}}{\widehat{T}} - \delta \frac{\widehat{M^A}}{\widehat{T}} \right] \end{aligned} \quad (7a)$$

Where,  $\delta = \frac{M^A}{M^A + M^{*A'}} > 0$  and  $(1 - \delta) = \frac{M^{*A'}}{M^A + M^{*A'}} > 0$

Also, Equation (1)

$$\Rightarrow \frac{\widehat{w_S}}{\widehat{T}} = -\frac{\theta_{MX}^A}{\theta_{SX}^A} < 0 \quad (1a)$$

Where  $\theta_{MX}^A = T a_{MX}^A > 0$  and  $\theta_{SX}^A = w_S a_{SX}^A > 0$

Also, from Equation (1), we have

$$\begin{aligned} \theta_{SX}^A \widehat{a_{SX}^A} + \theta_{MX}^A \widehat{a_{MX}^A} &= 0 \\ \Rightarrow \frac{\widehat{a_{MX}^A}}{\widehat{T}} &= -\frac{\theta_{SX}^A}{\theta_{MX}^A} \frac{\widehat{a_{SX}^A}}{\widehat{T}} \end{aligned} \quad (1b)$$

From the definition of elasticity of substitution ( $\sigma$ ), we have

$$\sigma_X^A = \frac{\widehat{a_{MX}^A} - \widehat{a_{SX}^A}}{\widehat{w_S} - \widehat{T}} > 0 \quad (27)$$

Substituting the values of  $\frac{\widehat{a_{SX}^A}}{\widehat{T}}$  and  $\frac{\widehat{w_S}}{\widehat{T}}$  from Equations (1a) and (1b) in Equation (27), we get

$$\frac{\widehat{a_{MX}^A}}{\widehat{T}} = -\sigma_X^A \quad (28)$$

and therefore, from Equation (1b), we get  $\frac{\widehat{a_{SX}^A}}{\widehat{T}} = \frac{\theta_{MX}^A}{\theta_{SX}^A} \sigma_X^A$  (29)

From Equation (4) and Equation (29), we have

$$\frac{\widehat{X^A}}{\widehat{T}} = -\frac{\theta_{MX}^A}{\theta_{SX}^A} \sigma_X^A \quad (4a)$$

Further, from Equations (5) and (6), it can be derived that

$$\frac{\widehat{M^A}}{\widehat{T}} = \frac{\lambda_{KY}^A \gamma_L + \lambda_{LY}^A \gamma_K}{|\lambda| |\theta|} \quad (5a)$$

Where,  $\lambda_{LY}^A = \frac{a_{LY}^A \gamma_Y^A}{L^A} > 0$ ,  $\lambda_{KY}^A = \frac{a_{KY}^A \gamma_Y^A}{K^A} > 0$ ,  $\lambda_{LM}^A = \frac{a_{LM}^A M^A}{L^A} > 0$ ,

$$\lambda_{KM}^A = \frac{a_{KM}^A M^A}{K^A} > 0, \quad \gamma_L = (\lambda_{LM}^A \sigma_M^A \theta_{KM}^A + \lambda_{LY}^A \sigma_Y^A \theta_{KY}^A) > 0,$$

$$\gamma_K = (\lambda_{KM}^A \sigma_M^A \theta_{LM}^A + \lambda_{KY}^A \sigma_Y^A \theta_{LY}^A) > 0$$

Now, we have  $|\theta| = \theta_{KM}^A \theta_{LY}^A - \theta_{KY}^A \theta_{LM}^A$ ,  $|\lambda| = (\lambda_{KM}^A \lambda_{LY}^A - \lambda_{KY}^A \lambda_{LM}^A)$

So, under the assumption that  $M$  is more capital intensive than  $Y$ , i.e.,  $\frac{a_{KM}^A}{a_{LM}^A} > \frac{a_{KY}^A}{a_{LY}^A}$ , we see that  $|\lambda| > 0$  and  $|\theta| > 0$ .

Finally, substituting the values of  $\frac{\widehat{a_{MX}^A}}{\widehat{T}}$ ,  $\frac{\widehat{X^A}}{\widehat{T}}$ ,  $\frac{\widehat{M^A}}{\widehat{T}}$  from Equations (28), (4a) and (5a) respectively in Equation (7a), we get

$$\frac{\widehat{M^{*A'}}}{\widehat{T}} = \frac{1}{(1-\delta)} \left[ -\delta \frac{(\lambda_{KY}^A \gamma_L + \lambda_{LY}^A \gamma_K)}{|\lambda| |\theta|} - \frac{\sigma_X^A}{\theta_{SX}^A} \right] < 0 \quad (\text{Proved})$$

## The impact of foreign direct investment on carbon emissions in China: a provincial panel data analysis

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**Abstract.** *This paper analyzes China's provincial data from 2004 to 2021 using a panel regression analysis model to examine the impact of foreign direct investment (FDI) growth on China's carbon emissions. The empirical results show that: 1) FDI, GDP per capita, industrial structure, and fiscal investment significantly contribute to increased carbon emissions, while economic openness has a significant negative effect. 2) From the perspective of regional samples, FDI in the eastern and central regions positively influences carbon emissions, with GDP per capita having a positive effect on the eastern region and a negative one in the central and western regions. Industrial structure, fiscal investment, and population also significantly affect carbon emissions, highlighting regional economic and structural disparities. The analysis suggests that early environmental protection inadequacies and the influx of high-pollution, high-energy industries due to FDI contributed to rising emissions. Therefore, this study recommends enhancing FDI quality standards, limiting high-pollution industries, and promoting investment in green technologies to foster a low-carbon economy.*

**Keywords:** foreign direct investment, carbon emissions, China, two-way fixed effects.

**JEL Classification:** F21, O53, Q53, C33.

## 1. Introduction

In recent years, China has actively participated in international trade and industrial relocation, attracting significant foreign direct investment (FDI). While FDI has driven China's rapid economic growth, it has also significantly impacted the country's carbon emissions. Some multinational corporations from developed countries have transferred their domestic "sunset industries" to China through FDI, placing considerable pressure on the environment. This has led to a continuous increase in carbon emissions, posing substantial challenges to economic and social development. Therefore, reducing carbon emissions, advancing the rapid development of a low-carbon economy, and appropriately attracting FDI to accelerate industrial restructuring have become urgent needs.

Existing research on the impact of FDI on China's carbon emissions presents mixed findings. Some studies support the pollution haven hypothesis, suggesting that FDI leads to increased emissions as firms move operations to China. In contrast, other studies endorse the pollution halo hypothesis, arguing that FDI can enhance China's environmental quality by introducing cleaner technologies and more sustainable practices. Zhai and Wang (2022) found that FDI increases carbon emissions in the short term but reduces them in the long term. Based on panel data from Chinese cities between 2005 and 2019, Biao and Zhang (2023) found that FDI can significantly reduce China's carbon emissions. Similarly, studies by Dang (2018), Hao et al. (2021), Wang and Wang (2022), and Li (2023) have also identified a pollution halo effect (green technology spillover effect) of FDI, indicating that FDI significantly reduces carbon emissions. In addition, Sung et al. (2018) utilized panel data from 28 sub-industries within China's manufacturing sector spanning the years 2002 to 2015 to examine the influence of FDI inflows on carbon emissions in China. Their findings indicated that FDI diminished the pollution halo effect associated with carbon emissions in China. In contrast, research by Yu et al. (2016), Wang et al. (2019), Lu and Luo (2021), and Liu (2023) suggests that the rapid inflow of FDI has continued to increase China's carbon emissions. Furthermore, Xie and Xu (2019) pointed out that at low levels of FDI, carbon emissions increase, whereas at higher levels of FDI, carbon emissions are suppressed. Regarding the impact of FDI on carbon emissions in different regions of China, Huang (2017) noted that FDI has varying effects across the eastern, central, and western regions. Specifically, FDI reduces carbon emissions in the eastern and central regions, while it leads to an increase in carbon emissions in the western region. Based on an analysis of China's carbon emissions data from 2001 to 2019, Fang et al. (2022) found that FDI has a significant inhibitory effect on China's carbon emissions. However, this effect is limited to the eastern and central regions, where FDI reduces carbon emissions, while FDI in the western region shows no such inhibitory effect. Additionally, Wei and Ji (2023) highlighted that there is a nonlinear relationship between FDI and carbon emissions in the western region.

Existing research has extensively examined the relationship between FDI and carbon emissions. However, much of this analysis relies on national or provincial panel data, which imposes significant limitations on the robustness and generalizability of the conclusions.

The findings often lack consistency, owing to variations in regional, industrial, and temporal dimensions. This inconsistency may arise from heterogeneity in data samples, methodological approaches, and the specific variables emphasized in different studies. Consequently, the complexity of the relationship between FDI and carbon emissions remains insufficiently elucidated. Furthermore, factors such as regional disparities in economic development, industrial structure, and environmental policy frameworks may result in substantial variations in the impact of FDI on carbon emissions, further complicating the analysis. While existing studies have contributed valuable theoretical insights and empirical evidence on the relationship between FDI and carbon emissions, a unified conclusion regarding the environmental effects of FDI remains elusive. This lack of consensus can be attributed to variations in research scope, data dimensions, and industry-specific differences. In the context of China's economic structural transformation, industrial realignment, and the implementation of increasingly stringent environmental policies, analyzing the impact of FDI on carbon emissions is of significant practical relevance. However, numerous existing studies fail to account for the influence of regional heterogeneity on the environmental impacts of FDI, thereby limiting the comprehensiveness and robustness of their conclusions. Addressing this research gap necessitates a more nuanced investigation into the specific impact of FDI on carbon emissions, which is pivotal for reconciling economic development with environmental sustainability. This study employs a panel regression analysis model, utilizing provincial panel data from China spanning 2004 to 2021, to systematically examine the influence of FDI on carbon emissions. This study will first conduct a comprehensive review of the relevant literature to summarize progress in understanding the relationship between FDI and carbon emissions. Second, this study will develop a panel model to analyze the specific mechanisms through which FDI impacts carbon emissions in depth. Finally, based on the empirical findings, this study will propose targeted policy recommendations to provide policymakers with actionable insights and theoretical guidance for advancing green development objectives.

## 2. Literature Review

The impact of FDI on the environmental performance of host countries has been the subject of extensive research, yielding varying results depending on the context and period analyzed. Based on an analysis of Turkish panel data from 1974 to 2010, Gökmenoğlu and Taspınar (2016) found that FDI is a long-term determinant of Turkey's carbon emissions, suggesting that FDI has a promoting effect on carbon emissions. Bakhsh et al. (2017), utilizing an annual dataset covering the period from 1980 to 2014, identified a positive correlation between FDI and pollution in Pakistan. Adeel-Farooq et al. (2021) utilized panel data from 76 countries spanning the period 2002 to 2012 to analyze the environmental impact of FDI originating from both developed and developing countries on the host countries. Their findings indicated that FDI from developed countries enhanced the overall

environmental performance of low-income, lower-middle-income, and upper-middle-income host countries. Conversely, FDI from developing countries negatively affected the environmental performance of low-income and lower-middle-income host countries.

In contrast, studies focusing on China present a more nuanced perspective on the environmental effects of FDI. Fang et al. (2010) highlighted that FDI brings not only capital and technology but also positive environmental effects to China. Research by Xu and Deng (2012), Yu and Zhang (2016), as well as Li et al. (2017), emphasized the role of FDI in enhancing China's ecological efficiency and reducing environmental pollution through technology spillovers. These studies collectively argue that FDI contributes positively to China's environmental protection efforts and is not a primary cause of environmental degradation. However, other scholars present contrasting evidence. He and Wang (2012), along with Wang (2013), found a correlation between increased FDI and higher industrial wastewater discharge in China, indicating a negative environmental impact of FDI. Bao and Chen (2012) further refined this perspective by asserting that the environmental consequences of FDI depend on the targeted industry, with pollution-intensive sectors exacerbating environmental degradation, while FDI in cleaner sectors follows a U-shaped trajectory, initially reducing pollution before reaching a threshold where it increases again.

The above previous studies demonstrate that the relationship between FDI and the host country's environment is multifaceted and context-dependent. FDI has the potential to generate positive environmental benefits, such as enhancing ecological efficiency, facilitating the adoption of green technologies, and reducing environmental pollution. In contrast, under certain conditions, particularly in resource-intensive and highly polluting industries, the inflow of foreign capital may lead to adverse environmental consequences, exacerbating local pollution and intensifying environmental pressures. Therefore, a comprehensive understanding of the FDI-environment nexus is essential for accurately evaluating its overall effects and formulating balanced policies.

Moreover, the nature and industrial characteristics of FDI exert varying influences across different economic contexts. For instance, FDI in high-tech and clean energy sectors often introduces advanced technologies and management practices, thereby enhancing ecological efficiency and reducing emissions of carbon and other pollutants. Conversely, in traditional and resource-intensive industries, FDI may contribute to resource overexploitation and environmental degradation. This issue is particularly pronounced in regions with relatively weak environmental oversight, where foreign enterprises may prioritize cost minimization over compliance with environmental standards, further exacerbating environmental pressures. Previous studies have also highlighted that FDI exerts varying effects on environmental issues, such as carbon emissions and wastewater discharge, depending on the industrial sector. For instance, FDI in manufacturing and heavy chemical industries is often associated with higher energy consumption and increased pollution. In contrast, FDI in service sectors and high-tech industries tends to have a more favorable environmental impact, potentially contributing to sustainable development.



Although the existing literature offers valuable insights into the relationship between FDI and environmental outcomes, inconsistencies persist due to variations in research scope, data sources, and model specifications. Regarding the environmental impacts across different regions of China, current research has not sufficiently addressed the heterogeneous effects of FDI on carbon emissions at the regional level. This study seeks to address this gap by employing empirical analysis based on provincial panel data from China spanning 2004 to 2021, to examine the specific impact of FDI on carbon emissions and elucidate the underlying mechanisms.

### 3. Model and Data

Previous studies have indicated that factors such as FDI, GDP per capita, industrial structure, and fiscal expenditure significantly influence a country's carbon emissions (Hao et al., 2021; Zhai and Wang, 2022; Fang et al., 2022). In line with these findings, this study employs the carbon emissions (CO<sub>2</sub>) of each province and city as the dependent variable, while FDI, GDP per capita, industrial structure (Industry rate), fiscal investment (Fiscal investment), economic openness (Openness), and total population (Population) of each province and city serve as independent variables. These variables are incorporated into a panel data analysis model for further investigation.

The panel data analysis equation constructed in this paper is as follows:

$$\ln CO_{2it} = \alpha_0 + \beta_1 \ln FDI_{it} + \beta_2 \ln GDP\_per\_capita_{it} + \beta_3 \ln Industry\_rate_{it} + \beta_4 \ln Fiscal\_investment_{it} + \beta_5 \ln Openness_{it} + \beta_6 \ln Population_{it} + \varepsilon_{it} \quad (1)$$

Among them,  $\alpha_0$  is a constant term;  $i$  refers to the provinces and cities;  $t$  refers to the year;  $\beta_i$  is the regression coefficient;  $\ln FDI_{it}$  is the logarithm of FDI in province or city  $i$  in year  $t$ ;  $\ln GDP\_per\_capita_{it}$  is the logarithm of GDP per capita in province or city  $i$  in year  $t$ ;  $\ln Industry\_rate_{it}$  is the logarithm of the industrial structure coefficient in province or city  $i$  in year  $t$ ;  $\ln Fiscal\_investment_{it}$  is the logarithm of fiscal investment in province or city  $i$  in year  $t$ ;  $\ln Openness_{it}$  is the logarithm of the degree of openness of province or city  $i$  in year  $t$ ;  $\ln Population_{it}$  is the logarithm of the population of province or city  $i$  in year  $t$ ;  $\varepsilon_{it}$  is the error term.

Based on the analytical model outlined above and considering data availability, this study employs panel data from 30 provinces and municipalities in China, covering the period from 2004 to 2021, for estimation purposes. The data primarily come from *the China Statistical Yearbook* and the official website of the National Bureau of Statistics. To mitigate the potential effects of heteroscedasticity and outliers, the selected variables are logarithmically transformed. The definitions of each variable are presented in Table 1, while the descriptive statistics for each variable are provided in Table 2.

**Table 1.** Explanation of variable meaning

Variables	Units	The meaning of each variable
CO <sub>2</sub>	Million tons	Total carbon emissions of each province and city
FDI	Million US \$	Total FDI of each province and city
GDP per capita	Yuan	GDP per capita of each province and city
Industry structure ( Industry rate)	%	The total value of the secondary industry to GDP of each province and city
Fiscal investment	%	Fiscal investment to GDP of each province and city
Economic openness	%	Total exports to GDP of each province and city
Total population	10,000 people	Total population of each province and city

**Source:** Author's calculations.

**Table 2.** Descriptive statistics

Variable	Obs.	Mean	Std.Dev.	Min	Max	Data Source
CO <sub>2</sub>	540	325.582	285.434	7.555	2,099.792	Institute of Public and Environmental Affairs
FDI	540	169,861.689	360,543.365	700	4,527,200	China Statistical Yearbook
GDP_per_capita	540	42,902.852	29,620.281	4,244	187,526	National Bureau of Statistics
Industry_rate	540	0.425	0.083	0.160	0.620	China Statistical Yearbook
Fiscal_investment	540	0.233	0.107	0.089	0.758	National Bureau of Statistics
Openness	540	0.159	0.177	0.004	0.927	China Statistical Yearbook
Population	540	4,506.324	2,764.716	539	12,684	China Statistical Yearbook

**Source:** Author's calculations.

Before conducting panel data analysis, it is essential to evaluate the stationarity of the variables. This study employs the Levin-Lin-Chu (LLC) test and the Im-Pesaran-Shin (IPS) test to perform panel unit root tests on the variables. These methods are instrumental in determining the presence of unit roots and assessing the stationarity of the time series data, thereby ensuring the reliability and validity of the subsequent analyses. The results of the panel unit root tests are presented in Table 3.

The results of the LLC test and the IPS test indicate that the p-values for the variables *lnFDI*, *lnGDP\_per\_capita*, *lnIndustry\_rate*, and *lnFiscal\_investment* exceed 0.05. Therefore, the null hypothesis of "the presence of unit roots" cannot be rejected, suggesting that these variables are non-stationary in their original form. However, the p-values for all first-order differenced variables are less than 0.05, allowing the rejection of the null hypothesis. This indicates that the differenced data series are stationary.

**Table 3.** Results of the panel unit root tests

	LLC test		IPS test	
	P-value	Stationarity	P-value	Stationarity
Level				
<i>lnCO<sub>2</sub></i>	0.0000	stationary	0.0000	stationary
<i>lnFDI</i>	0.9914	non-stationary	0.9670	non-stationary
<i>lnGDP_per_capita</i>	0.0134	stationary	0.1520	non-stationary
<i>lnIndustry_rate</i>	0.0171	stationary	0.2494	non-stationary
<i>lnFiscal_investment</i>	0.0000	stationary	0.1016	non-stationary
<i>lnOpenness</i>	0.0005	stationary	0.0032	stationary

	LLC test		IPS test	
<i>lnPopulation</i>	0.0000	stationary	0.0039	stationary
<i>1st difference</i>				
$\Delta \ln CO_2$	0.0000	stationary	0.0000	stationary
$\Delta \ln FDI$	0.0000	stationary	0.0000	stationary
$\Delta \ln GDP\_per\_capita$	0.0000	stationary	0.0000	stationary
$\Delta \ln Industry\_rate$	0.0000	stationary	0.0000	stationary
$\Delta \ln Fiscal\_investment$	0.0000	stationary	0.0000	stationary
$\Delta \ln Openness$	0.0000	stationary	0.0000	stationary
$\Delta \ln Population$	0.0000	stationary	0.0000	stationary

**Source:** Author's calculations.

Based on the results of the panel data unit root tests, which show that the original variables exhibit unit roots while the first-differenced variables do not, this study employs the Pedroni panel cointegration test to assess the existence of a cointegration relationship among the variables. The p-value of the Pedroni panel cointegration test is less than 0.05, leading to the rejection of the null hypothesis of no cointegration. This indicates the presence of a cointegration relationship in the panel data, suggesting that the regression analysis model is not subject to spurious regression issues, and therefore, regression analysis can be conducted directly.

## 4. Analysis Results

### 4.1. Benchmark analysis results

Since the p-values of both the F-test and the Hausman test are less than 0.05, this study adopts the fixed effects model. Table 4 presents the results of the benchmark analysis. The estimation results of model (2) indicate that the variables of FDI, GDP per capita, industrial structure, fiscal investment, and openness all pass the significance test. Among them, FDI, GDP per capita, industrial structure, and fiscal investment all have a significant positive impact on China's carbon emissions, whereas openness demonstrates a significant negative effect on carbon emissions. These findings suggest that both FDI and economic growth contribute to an increase in carbon emissions, while an improvement in openness helps to mitigate carbon emissions.

**Table 4.** Results of Benchmark analysis

	Model (1) Pooled OLS	Model (2) FE	Model (3) RE
<i>lnFDI</i>	-0.0094 (0.7997)	0.0612** (0.0189)	0.0556** (0.0310)
<i>lnGDP_per_capita</i>	0.5201*** (0.0000)	0.3409*** (0.0054)	0.3690*** (0.0011)
<i>lnIndustry_rate</i>	1.5377*** (0.0000)	0.3715*** (0.0090)	0.4887*** (0.0002)
<i>lnFiscal_investment</i>	0.3261*** (0.0007)	0.5647*** (0.0000)	0.5748*** (0.0000)
<i>lnOpenness</i>	-0.1381*** (0.0001)	-0.0501* (0.0669)	-0.0545** (0.0459)

	Model (1) Pooled OLS	Model (2) FE	Model (3) RE
<i>lnPopulation</i>	0.6869*** (0.0000)	0.1431 (0.4610)	0.6199*** (0.0000)
<i>Constant</i>	-3.9469*** (0.0000)	1.1631 (0.5962)	-2.8080* (0.0714)
Individual effects	No	Yes	No
Time effects	No	Yes	Yes
<i>N</i>	540	540	540
adj. $R^2$ and $R^2$	0.6496	0.6821	0.7085

**Note:** \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5%, and 10% levels, respectively.

**Source:** Author's calculations.

The estimated coefficient of FDI is 0.0612, which is significantly positive at the 5% level. This indicates that for one unit increase in FDI, China's carbon emissions rise by 0.0612-unit, suggesting that FDI has significantly contributed to the increase in carbon emissions. The insufficient development of environmental regulations in China in the past has facilitated the transfer of high-pollution and high-energy-consuming industries from multinational corporations to China, further exacerbating carbon emissions. Consequently, as the scale of FDI in China has expanded, carbon emissions have also increased.

The estimated coefficient of GDP per capita is 0.3409, which is significantly positive at the 1% level. This indicates that for one unit increase in GDP per capita, China's carbon emissions rise by 0.3409-unit. The rapid development of China's economy has been accompanied by a sharp increase in carbon emissions, highlighting that significant economic progress has largely been achieved at the expense of environmental sustainability, leading to higher carbon emissions.

The estimated coefficient of industrial structure is 0.3715, which is significantly positive at the 1% level. This suggests that for one unit change in industrial structure, China's carbon emissions increase by 0.3715-unit. A key factor contributing to this rise in carbon emissions is the disproportionately high share of the secondary industry in China's overall industrial structure. Although China is actively adjusting its industrial structure to reduce reliance on high-energy-consuming industries, the secondary sector, particularly manufacturing, continues to play a significant role within China's overall industrial framework. At this stage, a substantial proportion of high-energy-consuming industries remain embedded in China's industrial structure, and the persistence of these industries exerts considerable pressure on carbon emissions.

The estimated coefficient of fiscal investment is 0.5647, which is significantly positive at the 1% level. This indicates that for one unit increase in fiscal investment, China's carbon emissions rise by 0.5647-unit. Despite the increased fiscal investment by local governments in recent years aimed at carbon emissions control, the implementation of local carbon reduction policies remains insufficient, contributing to the continued rise in carbon emissions. Additionally, the expansion of infrastructure development by local governments in recent years has also played a role in driving the increase in carbon emissions.

Finally, the estimated coefficient of openness is -0.0501, which is significantly negative at the 10% level. This indicates that for one unit increase in openness, China's carbon emissions decrease by 0.0501-unit. In regions where export trade constitutes a significant portion of the local economic structure, the connection with the global economic market is stronger, leading to greater attention to carbon emissions and environmental sustainability. Moreover, regions with higher levels of openness have more opportunities to attract FDI and tend to have stronger enforcement of environmental policies.

#### **4.2. Robustness test**

This study employs the method of replacing independent variables to assess the robustness of the results obtained from the benchmark regression analysis. Given that both GDP and GDP per capita are effective indicators of a region's economic development level, adjustments are made accordingly in the robustness test model. Specifically, GDP per capita is substituted with GDP in the benchmark analysis model to examine the impact of economic development on the research outcomes. Using GDP as an independent variable not only more comprehensively reflects the overall scale of regional economic development but also mitigates potential biases in GDP per capita that may arise from fluctuations in population size, thus offering a more nuanced perspective for analysis. The estimation results of the stability test are presented in Table 5.

The estimation results of the stability test indicate that variables such as FDI, GDP, industrial structure, fiscal investment, and openness all pass the significance test. Specifically, FDI, GDP, industrial structure, and fiscal investment exhibit significant positive effects on carbon emissions, while openness shows a significant negative effect. The estimated coefficient of GDP is 0.0624, suggesting that an increase in GDP corresponds with a rise in carbon emissions. This result is nearly identical to the estimated coefficient of GDP per capita in the benchmark regression (0.0612), indicating consistent impact trends and further validating the robustness of the findings. These findings are consistent with previous studies, suggesting that economic growth is frequently associated with increased energy consumption, which in turn leads to higher carbon emissions. Regarding FDI, its positive and significant impact indicates that the inflow of foreign capital has not only fostered economic development but has also contributed to higher carbon emissions. Furthermore, the adjustment of industrial structure plays a crucial role in determining carbon emissions. In regions with a relatively simple industrial structure that relies heavily on heavy industry and high-pollution sectors, carbon emissions are likely to increase substantially.

On the other hand, openness demonstrates a significant negative impact on carbon emissions, suggesting that in an open economic environment, environmental awareness and technology transfer have improved. Openness facilitates the introduction of clean technologies and enhances the environmental standards and awareness of local enterprises, thereby contributing to a reduction in carbon emissions. Additionally, the estimated coefficients of other key variables are consistent with those obtained in the benchmark regression, further corroborating the robustness of the conclusions drawn from the benchmark analysis in this study.

### 4.3. Endogeneity test

When analyzing the relationship between FDI and carbon emissions, issues like reverse causality and omitted variable bias can result in endogeneity problems. To address these concerns, a widely used approach involves identifying a suitable instrumental variable that is strongly correlated with FDI but either uncorrelated with carbon emissions or only weakly related to them. This instrumental variable is then employed within a two-stage least squares (2SLS) estimation framework, enhancing the robustness and reliability of causal inference. Specifically, in the first stage, the instrumental variable is regressed on FDI to obtain its predicted values. In the second stage, these predicted values are used as a substitute for actual FDI to assess its impact on carbon emissions. This study selects the mileage of highways in various provinces and cities of China as an instrumental variable to address the potential endogeneity issue between FDI and carbon emissions. The change in highway mileage is primarily influenced by policy initiatives, regional economic development, and government investment. While it has a weak direct causal relationship with carbon emissions, it is closely related to FDI. By using highway mileage as an instrumental variable, this approach effectively mitigates endogeneity issues such as reverse causality or omitted variable bias, thereby enhancing the accuracy of the estimation of the relationship between FDI and carbon emissions.

**Table 5.** Results of Robustness, Endogeneity, and Heterogeneity test

	Robustness test	Endogeneity test	Heterogeneity test		
			Model (1) Eastern Region	Model (2) Central Region	Model (3) Western Region
<i>lnFDI</i>	0.0624** (0.0169)	0.6847** (0.0314)	0.0620** (0.0461)	0.1430** (0.0439)	0.0611 (0.1497)
<i>lnGDP_per_capita</i>		-0.4578 (0.3028)	1.1651*** (0.0000)	-1.3520*** (0.0000)	-0.8206** (0.0008)
<i>lnGDP</i>	0.3257*** (0.0089)				
<i>lnIndustry_rate</i>	0.3838*** (0.0071)	2.3486*** (0.0000)	0.4439* (0.0715)	0.2104 (0.4580)	0.3736 (0.1368)
<i>lnFiscal_investment</i>	0.5597*** (0.0000)	0.9713*** (0.0017)	0.5694*** (0.0002)	-0.3404 (0.3823)	-0.1420 (0.5283)
<i>lnOpenness</i>	-0.0488* (0.0739)	-0.3319*** (0.0008)	-0.1078 (0.2818)	-0.1454* (0.0564)	-0.0366 (0.2485)
<i>lnPopulation</i>	-0.1893 (0.3130)	0.2827 (0.1489)	-0.1327 (0.6533)	3.6604*** (0.0000)	1.0255** (0.0129)
<i>Constant</i>	4.3551*** (0.0048)	3.2467 (0.3285)	-4.6759 (0.1409)	-15.9507** (0.0217)	3.2954 (0.4168)
Individual effects	Yes	-	Yes	Yes	Yes
Time effects	Yes	-	Yes	Yes	Yes
<i>N</i>	540	540	198	144	198
adj. <i>R</i> <sup>2</sup> and <i>R</i> <sup>2</sup>	0.6815	0.6525	0.7060	0.6824	0.8184

**Note:** 1) \*\*\*, \*\* and \* denote 1%, 5%, and 10% significance levels, respectively.

2) The eastern region includes Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan; the central region includes Heilongjiang, Jilin, Shanxi, Anhui, Jiangxi, Henan, Hubei, and Hunan; the western region includes Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang.

**Source:** Author's calculations.

Table 5 presents the estimation results obtained using the instrumental variable method (2SLS), which further investigates the impact of FDI on carbon emissions. The 2SLS estimation results indicate that variables such as FDI, industrial structure, fiscal investment, and openness all pass the significance test. Specifically, FDI, industrial structure, and fiscal investment have a significant positive impact on carbon emissions, suggesting that while these factors contribute to economic growth, they also facilitate an increase in carbon emissions. Meanwhile, openness significantly reduces carbon emissions, which is closely linked to the introduction of green technologies and the strengthening of environmental regulation. Furthermore, the 2SLS estimation results indicate that, after correcting for endogeneity, the conclusions derived from the benchmark regression remain robust, thereby reinforcing the core finding of this paper regarding the impact of FDI on carbon emissions.

#### **4.4. Heterogeneity test**

Due to significant variations in economic development levels and the endowment of economic factors across provinces in China, the impact of FDI on carbon emissions exhibits notable heterogeneity. This regional disparity indicates that the effects of FDI on carbon emissions differ substantially across regions. In more developed regions, FDI tends to lead to an increase in carbon emissions, whereas in less developed regions, the effect may be more moderate, or even inhibitory, on carbon emissions. To further investigate the specific impact of FDI on China's carbon emissions, this study classifies the 30 provinces and cities across the country into three regions—eastern, central, and western—based on geographical differences and economic development levels. This classification allows for a clearer understanding of how economic structures, industrial development, and environmental protection policies in different regions influence carbon emissions through FDI. By conducting separate group regression analyses, this paper aims to explore the regional heterogeneity in the impact of FDI on carbon emissions. The estimated results of the heterogeneity test are presented in Table 5.

The results of the heterogeneity test provide a deeper analysis of the impact of FDI on carbon emissions, particularly in the eastern and central regions. The significance test results indicate that FDI in both regions has a significantly positive impact on carbon emissions, suggesting that an increase in FDI leads to higher carbon emissions in these areas. The business activities of foreign-funded enterprises in these regions are closely associated with elevated carbon emissions. Additionally, the impact of GDP per capita reveals regional differences. While GDP per capita in the eastern, central, and western regions has all passed the significance test, the direction of its impact on carbon emissions varies considerably across regions. In the eastern region, GDP per capita is positively correlated with carbon emissions, indicating that rapid economic growth is accompanied by an increase in carbon emissions to some extent. This relationship can be attributed to the prevalence of high-energy-consuming industries, high consumption levels, and the rapid expansion of infrastructure in the eastern region. In contrast, GDP per capita in the

central and western regions exerts a negative impact on carbon emissions, suggesting that economic development in these regions does not necessarily result in increased carbon emissions, but rather contributes to the suppression of their growth to some extent. This can be attributed to the prevalence of more environmentally friendly industries in these regions, or to relatively low levels of energy consumption and the influence of policy orientations that prioritize sustainability.

In addition to the impact of GDP per capita, the industrial structure and fiscal investment in the eastern region also passed the significance test. This indicates that the rationality of the industrial structure and the effective allocation of fiscal funds are directly related to the level of carbon emissions. If the eastern region can further optimize its industrial structure and promote the development of high-tech and low-emission industries, it could foster high-quality economic growth while simultaneously controlling carbon emissions. Additionally, openness and total population in the central region, as well as the total population in the western region, have passed the significance test, indicating that these factors significantly influence carbon emissions. Openness in the central region is closely associated with the inflow of foreign-funded enterprises and the dynamism of regional economic development. Meanwhile, an increase in the total population corresponds to higher energy demand and consumption, thereby contributing to an increase in carbon emissions. In the western region, population similarly drives greater demand for resources and energy, which in turn impacts the level of carbon emissions.

The estimated coefficients for the eastern and central regions are 0.0620 and 0.1430, both of which exhibit significant positive correlations at the 5% significance level. This indicates that the increase in FDI positively influences carbon emissions in both regions, though the magnitude of this impact differs. Specifically, the estimated coefficient of FDI in the eastern region is nearly identical to that of the total sample, suggesting that the impact of FDI on carbon emissions in the eastern region is relatively balanced. This can be attributed to the maturity of the economic structure, the advancement of the industrial chain, and the heightened awareness of environmental protection in the eastern region.

In contrast, the estimated coefficient of FDI in the central region is significantly higher than the 0.0612 observed for the total sample, indicating that the increase in FDI has a more pronounced effect on carbon emissions in the central region. This can be attributed to the fact that during the process of industrial transformation and upgrading in the central region, the influx of foreign-funded enterprises is often associated with higher energy consumption and environmental pollution, which contributes to a marked increase in carbon emissions. In addition, from the perspective of GDP per capita, the coefficient for the eastern region is considerably higher than the estimated coefficient for the total sample, further indicating that economic development has a significantly greater impact on carbon emissions in the eastern region. This phenomenon highlights the growing tension between economic growth and environmental sustainability, as the rapid economic development in the eastern region is accompanied by a substantial increase in carbon emissions.



In the central and western regions, the impact of GDP per capita on carbon emissions is negative, suggesting that economic development has not contributed to an increase in carbon emissions, but rather has partially mitigated their growth. This is attributed to the industrial structure, energy efficiency, and policy orientation in these regions, indicating that they place greater emphasis on sustainable development and environmental protection measures while pursuing economic growth. Furthermore, the estimated coefficient of fiscal investment in the eastern region is nearly identical to that of the total sample, indicating that the increase in fiscal investment has contributed to the growth of carbon emissions in the region to some extent. This phenomenon is linked to the fact that a substantial portion of fiscal funds in the eastern region is allocated to infrastructure development, industrial expansion, and social welfare. While these investments foster rapid economic growth, they also lead to higher resource consumption and environmental pressure, which, in turn, exacerbates the rise in carbon emissions.

Meanwhile, the estimated coefficient of industrial structure in the eastern region is slightly higher than that of the total sample, suggesting the continued presence of high-energy-consuming industries in the region. Industries such as heavy industry and traditional manufacturing directly contribute to the increase in carbon emissions. Therefore, the eastern region must accelerate the adjustment of its industrial structure and promote the development of emerging sectors, particularly green and low-carbon industries, in order to mitigate the negative environmental impact. In the central region, openness exerts a significantly stronger inhibitory effect on carbon emissions compared to the national average. During the process of economic liberalization, the central region has been able to effectively attract FDI and promote industrial upgrading, resulting in relatively lower carbon emissions. This phenomenon is closely linked to the region's policy orientation and industrial structure.

Finally, the population in the central and western regions has contributed to the increase in carbon emissions. Notably, the impact of population on carbon emissions in the central region is significantly greater than that in the western region. This suggests that, during the process of economic development and urbanization, population growth in the central region has led to greater energy demand and consumption pressure, thereby driving a more substantial increase in carbon emissions. Although the western region also experiences population growth, its relatively lower level of economic development and more environmentally sustainable industrial structure have led to a smaller increase in carbon emissions.

## **5. Discussion**

The analysis reveals that FDI, GDP per capita, industrial structure, and fiscal investment all have a significant positive impact on China's carbon emissions, however, openness effectively curbs the growth of carbon emissions. The benchmark regression results of this study confirm the findings of Yu et al. (2016), Wang et al. (2019), Lu and Luo (2021), and Liu (2023), which demonstrate that FDI inflows significantly contribute to the increase in

China's carbon emissions. Additionally, this study further elucidates the complexity and diversity of the impact of FDI on China's carbon emissions.

In addition, contrary to the pollution haven hypothesis supported by some studies, this paper finds that the impact of FDI on carbon emissions exhibits significant stage and regional characteristics. In the early stages of economic development, FDI often facilitates the transfer of high-pollution and high-energy consumption industries, owing to its relatively low technological threshold, thereby contributing to an increase in carbon emissions. However, as the quality of FDI improves and green technology spillover effects emerge, the impact of FDI on carbon emissions gradually shifts towards inhibition.

Furthermore, the regional impact of FDI exhibits significant asymmetry. The eastern region, with its more developed economy, stricter environmental protection policies, and the influx of high-quality FDI, has experienced effective diffusion of green technologies, leading to a notable reduction in regional carbon emissions. The central region is in a transitional phase, while the western region, characterized by relatively weaker infrastructure and slower industrial structure upgrades, has seen a more pronounced negative effect on carbon emissions. Finally, this study suggests that the impact of FDI on China's carbon emissions follows a phased trajectory. As the level of economic development improves and the policy environment is optimized, the effect of FDI has transitioned from promoting carbon emissions to inhibiting them. In other words, the environmental impact of FDI is not static, but is dynamically influenced by factors such as the stage of regional economic development, the extent of industrial structure upgrading, and the implementation of green policies.

Since the implementation of reform and opening-up in 1978, FDI has played a pivotal role in China's economic development by introducing substantial capital, advanced technology, and managerial expertise, thereby becoming a key driver of economic growth. In the initial stages of reform, China adopted a policy centered on attracting investment and prioritizing rapid economic growth. Through a series of preferential measures, this policy effectively attracted a significant number of foreign-funded enterprises, fostered the growth of an export-oriented economy, and bolstered China's position in the global economy. However, due to limited environmental awareness and the inadequacy of relevant laws and regulations at the time, several issues emerged during the investment attraction process. Specifically, the lack of stringent review procedures and the absence of a comprehensive environmental assessment mechanism resulted in many companies failing to conduct adequate environmental impact assessments before market entry, and some even obtained approval without meeting environmental protection standards. Furthermore, in the pursuit of economic growth, local governments often overlook the need for rigorous scrutiny of the environmental impacts of enterprises. As a result, some "three highs" enterprises (high pollution, high energy consumption, and high emissions) entered China. These enterprises not only failed to deliver the anticipated technology transfer and management experience sharing but also exacerbated environmental pollution, contributing to a continuous rise in

China's carbon emissions. In this context, Zhang et al. (2023) also noted that FDI can lead to the transfer of carbon emissions to the host country by relocating polluting industries and altering the energy structure. Therefore, in future efforts to attract FDI, the government should adopt a sound investment promotion strategy that prioritizes high-quality FDI. This includes continuously raising the entry thresholds for FDI, strengthening environmental access standards, and encouraging the inflow of environmentally responsible foreign-funded enterprises. At the same time, the government should impose restrictions on the entry of "three highs" enterprises. Such measures will facilitate a win-win outcome, fostering both economic development and environmental protection.

Although this study provides insights into the overall impact of FDI on carbon emissions, it has certain limitations. Unlike some existing studies that offer more detailed industrial and regional classifications when analyzing the impact of FDI on carbon emissions, this study does not specifically disaggregate FDI by industry or region. This limitation may restrict a deeper exploration of the varying effects of FDI on carbon emissions across different industries and regions. The impact of FDI on carbon emissions is significantly heterogeneous across sectors and regions. Therefore, future research should further examine the environmental impact of FDI in specific industries and regions to provide a more comprehensive understanding of its ecological effects and offer a more targeted, regionally adaptable basis for policymaking.

## 6. Conclusion and Policy Recommendations

This paper uses a panel regression analysis model to investigate the impact of FDI on China's carbon emissions, using provincial panel data spanning the years 2004 to 2021. The empirical results indicate the following: 1) From the perspective of the entire sample, FDI, GDP per capita, industrial structure, and fiscal investment all exhibit a significant positive effect on China's carbon emissions. In contrast, openness has a significant negative impact on carbon emissions. This suggests that traditional economic growth drivers contribute to increased carbon emissions during the early stages of development. However, greater openness—particularly the inflow of high-quality FDI—demonstrates a carbon emission-reducing effect, underscoring the importance of environmental governance within an open economy. 2) From the perspective of regional samples, there are significant differences in the impact of FDI on carbon emissions between the eastern and central regions. In the eastern region, the influence of FDI on carbon emissions is primarily driven by the promotion of high-tech industries, which indirectly facilitates green transformation. In contrast, in the central and western regions, the impact of FDI on carbon emissions is more pronounced through the expansion of resource-intensive and energy-consuming industries, owing to the slower pace of industrial structure upgrading. 3) This study posits that the impact of FDI on China's carbon emissions exhibits a phased transformation, with its effect shifting from promoting carbon emissions to inhibiting them as economic development advances and the policy environment improves. This finding suggests that the

environmental impact of FDI is not static, but is dynamically influenced by factors such as the stage of regional economic development, the upgrading of industrial structure, and the implementation of green policies.

In the early stages of China's development, the insufficient construction of environmental regulations led multinational companies to transfer high-pollution and energy-intensive production activities to China. As the scale of FDI gradually expanded, environmental protection measures were unable to effectively address the increased pressure exerted by FDI, resulting in a continued rise in China's carbon emissions. Despite the rapid growth of China's economy, this development has often come at the expense of the environment, leading to a significant increase in carbon emissions. Concurrently, the secondary sector continues to play a dominant role in China's economic structure, with the presence of numerous energy-intensive industries placing substantial pressure on carbon emissions. Although local governments have increased fiscal investment in carbon emissions control, the implementation of emission reduction policies remains inadequate, leading to a continued rise in China's carbon emissions. Additionally, nationwide infrastructure development has further stimulated the increase in carbon emissions to some extent.

The empirical analysis presented above indicates that the increase in FDI has contributed to the growth of carbon emissions in China. Based on these findings, the following policy recommendations are proposed:

- 1) Establish a scientific approach to investment promotion and enhance the quality of FDI. Prioritizing high-quality development in the promotion of FDI is essential. This can be achieved by optimizing the access mechanisms for FDI, raising environmental standards, and restricting the entry of "three highs" enterprises into China. Emphasis should be placed on attracting foreign-funded enterprises in high-tech and low-energy consumption sectors, leveraging their potential to drive green technologies, management innovations, and industrial upgrades. Additionally, a tiered management approach should be adopted for FDI at different stages. In the early stages of FDI inflow, enhanced environmental supervision of high-pollution industries is crucial to mitigate environmental risks. In the mature stage, policy guidance should aim to accelerate the spillover effects of green technologies, thereby reducing the negative impact of FDI on carbon emissions.
- 2) Enhance environmental standards and foster technological innovation to promote low-carbon economic development. The government should gradually strengthen environmental production standards for enterprises and improve regulatory mechanisms for high-pollution, high-energy consumption industries to reduce carbon emissions at their source. Additionally, policy incentives should be utilized to encourage enterprises to innovate in environmental protection technologies and expedite the adoption of green production practices. Concurrently, regional collaborative governance should be strengthened, and a unified national environmental standards system should be established. Given the regional disparities in development, the eastern region should

focus on advancing the “high-tech FDI + low-carbon economy” model, continuing to lead in green development. Meanwhile, the central and western regions should prioritize the introduction of green technologies and industrial structure adjustments to reduce dependence on high-pollution industries. By optimizing industrial structures, FDI should be directed toward high-tech, low-energy consumption sectors, thereby facilitating green transformation, and supporting sustainable development goals.

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## Quantitative insights into the impact of financial inclusion on economic growth: an econometric evaluation of Arab countries (2011-2022)

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**Abstract.** *This study aims to analyze the influence of financial inclusion on economic growth in Arab countries between 2011 and 2022, focusing on key indicators such as bank account ownership, access to financial services, and borrowing trends. The study highlights the main role of financial inclusion in promoting economic stability and supporting underserved communities across the region.*

*Using Feasible Generalized Least Squares (FGLS) within a fixed effects framework, the research addresses econometric challenges, including heteroskedasticity and autocorrelation, to accurately capture relationships within the data. Cluster analysis further categorizes countries based on financial inclusion performance, identifying leaders like the UAE, Bahrain, and Saudi Arabia, with Iraq ranking lower.*

*Findings reveal a statistically significant positive impact of access to bank accounts on economic growth, affirming the role of financial inclusion in driving economic stability. While access to financial services strongly correlates with growth, other indicators, such as borrowing levels, show weaker or insignificant effects, suggesting that broader financial access alone may not fully drive economic growth without supportive policies.*

**Keywords:** Financial Inclusion, Economic Growth, Feasible Generalized Least Squares, Cluster Analysis, Arab Countries.

**JEL Classification:** G21, O40, C13, C38, O53.

## Introduction

Financial inclusion has emerged as a significant factor in promoting economic development by providing access to basic financial services for all members of community. It refers to the process of ensuring that individuals and businesses, particularly those from underserved communities, can access affordable and appropriate financial products and services. These services include banking, credit, insurance, and savings, which are necessary for improving financial security and fostering economic growth. In recent years, the global movement towards financial inclusion has gained pace, particularly in developing regions, as policymakers recognize its potential to reduce poverty, improve social equity, and promote sustainable development.

In the Arab region, financial inclusion efforts have produced inconsistent outcomes. While countries such as the United Arab Emirates and Bahrain have made significant advancements in expanding access to financial services, others like Algeria and Iraq continue to face challenges in fully integrating their populations into the formal financial system. The disparities in financial inclusion across the region are influenced by various factors, including economic development levels, technological infrastructure, financial literacy, and regulatory environments. Understanding these differences is very important for identifying effective strategies to enhance financial inclusion and, in turn, promote economic growth.

This study aims to highlight the impact of financial inclusion on economic growth across a group of Arab countries during the period 2011-2022. By examining key financial inclusion indicator, such as bank account ownership, access to financial services, and borrowing trends, this research seeks to uncover the relationship between financial inclusion and economic development. The study employs econometric techniques, including feasible generalized least squares (FGLS) and cluster analysis, to analyze data from multiple Arab nations, providing insights into how financial inclusion contributes to growth and highlighting the region's leading and lagging performers.

## Study Objectives

The objectives of this study are as follows:

1. To investigate the impact of financial inclusion on economic development within a selected group of Arab countries during the period 2011-2022.
2. To analyze the role of financial inclusion in promoting financial and economic stability across Arab nations, highlighting its contribution to sustainable growth.
3. To assess the disparities in financial inclusion levels among Arab countries, with a focus on the leading economies such as the United Arab Emirates, and the lagging performance of countries like Algeria.
4. To evaluate the influence of innovative banking technologies on enhancing financial inclusion and their effectiveness in reaching underserved populations.
5. To explore the potential of financial inclusion as a driver for poverty reduction and economic growth in Arab economies, examining the mechanisms through which it supports development.



## Literature Review

Financial inclusion (FI) has emerged as a critical factor in promoting economic growth and development. Siddiki and Bala-Keffi (2024) highlight the theoretical benefits of FI, arguing that increased financial intermediation accelerates money circulation, thus fostering economic growth. They suggest that FI plays a pivotal role in facilitating economic activity and productivity, providing a theoretical foundation for understanding the various dimensions of FI's impact on economic growth.

Several studies have established a positive relationship between FI and economic growth. Kim, Yu, and Hassan (2018) highlight how global commitments to FI, particularly in the Organization of Islamic countries, result in long-term income growth and sustainable development. Using a panel vector autoregression (VAR) model, they reveal a bidirectional relationship between FI and economic growth in OIC countries. Mallick et al. (2016) explore the non-linear relationship between financial development and economic growth, concluding that FI contributes to resource efficiency, thereby enhancing economic development. Chauvet and Jacolin (2017) find that FI positively impacts firm performance, particularly in emerging markets, by improving competitiveness and productivity.

Regional and country-specific studies further support these findings. Van Dinh and Nguyen (2019) prove that FI promotes economic development in Asia-Pacific countries by improving socioeconomic outcomes through enhanced financial services. Adedokun and Aga (2021) focus on Sub-Saharan Africa, demonstrating (Smith, et al., 2003) suggesting that FI significantly fosters economic development in the region. Hasan et al. (2024) show that FI has a significant positive impact on economic growth in Bangladesh, demonstrating a strong correlation between FI and GDP growth. Their study concludes with policy recommendations emphasizing the role of FI in poverty reduction and economic development in developing nations. Additionally, Hussain et al. (2024) provide comparative evidence from developed and developing Asian countries, finding a strong long-term positive relationship between FI and economic growth, with the effects more pronounced in developing nations.

However, the impact of FI may vary across different economic levels. Sahay et al. (2015) suggest that while increased financial access can stimulate economic growth, this effect may diminish or even turn negative in certain developed countries. This finding reinforces the need for tailored FI policies, a conclusion supported by Karim et al. (2022), who argue that FI has a stronger growth-enhancing effect in developing and emerging markets compared to developed economies.

Various factors influence the effectiveness of FI in promoting economic growth. Demirgüç-Kunt and Klapper (2013) argue that FI levels vary across countries due to income differences, which further impact economic growth. Zins and Weill (2016) show that factors such as wealth, education, and gender significantly influence FI in Africa, which in turn affects economic outcomes. Owen and Pereira (2018) focus on variables such as bank concentration and financial stability, finding that these factors significantly affect economic growth by enhancing financial access.

The banking sector and financial regulation play crucial roles in shaping the impact of FI. Anarfo et al. (2020) examine the role of financial regulation in enhancing FI, showing that

effective regulation improves financial stability, which subsequently supports economic growth. Kebede et al. (2021) emphasizes that an excessive presence of foreign banks can reduce FI, potentially limiting economic growth. This suggests that FI must be balanced with appropriate banking policies to maximize its benefits. Ahamed et al. (2021) further show that inclusive banking improves overall bank performance, emphasizing the importance of the banking sector in fostering FI.

Technological advancements have also significantly influenced the relationship between FI and economic growth. Pradhan and Sahoo (2021) find that mobile financial services, in combination with FI, contribute to economic growth by increasing access to banking in underserved regions. Yakubi et al. (2020) find that digital financial inclusion drives socio-economic development, particularly in low-income countries.

Governance and human capital are additional factors that shape the impact of FI. Emará and El Said (2021) argue that good governance intensifies the positive effects of FI on growth, especially in countries with underdeveloped financial sectors. Boachie and Adu-Darko (2024) confirm the positive relationship between FI and economic growth, emphasizing the role of human capital in encouraging economic development.

The impact of FI extends beyond direct economic growth to broader social and economic outcomes. Neaime and Gaysset (2018) demonstrate that FI helps reduce income inequality and improve financial stability, both of which are essential for long-term economic growth. Khan et al. (2022) show that FI reduces poverty and income inequality in African countries, which further stimulates economic growth. Datta and Singh (2019) compare FI with the Human Development Index (HDI), demonstrating that FI significantly contributes to societal well-being by improving human development indicators. This corresponds with Sahay et al.'s (2015) findings, which highlight FI's dual impact on both economic growth (GDP) and social development (HDI).

FI also plays a role in promoting financial stability and mitigating the effects of economic crises. Ahamed and Mallick (2019) conclude that higher FI levels promote bank stability, which is critical for sustained economic growth. Lopez and Winkler (2019) provide evidence that higher levels of FI help reduce the adverse effects of financial crises, stabilizing economies during turbulent times.

Sector-specific impacts of FI have also been observed. Hu et al. (2021) examine the effect of FI on agricultural productivity, finding that FI significantly boosts productivity, especially in areas with higher financial access. This highlights FI's potential to drive growth in specific economic sectors. Furthermore, Hajilee and Niroomand (2019) investigate the short-term impact of FI on trade openness, showing that FI plays a crucial role in stimulating economic growth through its influence on trade activities.

While the benefits of FI are well-documented, it's equally important to consider the consequences of financial exclusion. Andreoni et al. (2008) draw attention to the severe consequences of financial exclusion, which exacerbates poverty and inequality. Their work highlights that individuals or regions lacking access to financial services face compounded issues, including unemployment, low income, and unstable environments. This financial

exclusion leads to further social disparity, reinforcing the gap between rich and poor, and ultimately hindering national economic development.

In conclusion, the literature consistently demonstrates a positive relationship between FI and economic growth, with particular emphasis on its impact in developing and emerging economies. However, the effectiveness of FI is influenced by various factors, including socioeconomic conditions, banking sector characteristics, technological advancements, and governance. As Le et al. (2019) point out, there is a positive relationship between FI and financial efficiency, underscoring that an inclusive financial system enhances resource allocation, which is crucial for economic growth.

### Study Methodology

This study investigates the relationship between financial inclusion and economic growth across Arab countries over a specified period. Data on various financial inclusion indicators were collected for the years 2011, 2014, 2017, and 2021, covering countries such as Algeria, Bahrain, Egypt, Iraq, Jordan, Kuwait, Lebanon, Saudi Arabia, Tunisia, and the UAE. The financial inclusion indicators included the percentage of adult individuals owning bank accounts, access to financial services such as credit cards and ATMs, usage of bank accounts for payments, savings in official financial institutions, and borrowing from these institutions.

To assess the suitability of the data for analysis, the Kolmogorov-Smirnov test was applied to determine whether the variables followed a normal distribution. Given that the variables did not exhibit normal distribution behavior, a hierarchical clustering method was employed. This clustering was based on the squared Euclidean distance to group countries with similar financial inclusion characteristics.

For the econometric evaluation, the study explored different models to determine the most appropriate one for analyzing the relationship between financial inclusion and economic growth. To address potential issues of heteroskedasticity and autocorrelation in the panel data, the Feasible Generalized Least Squares (FGLS) method was employed. These issues are prevalent when analyzing economic data across countries and time periods, where variances and correlations within each country's data points can vary significantly. Unlike Ordinary Least Squares (OLS), which assumes homoscedasticity and no autocorrelation, FGLS corrects for both by adjusting the standard errors, leading to more precise parameter estimates. This adjustment is essential because the variability in economic characteristics across countries (heteroskedasticity) and the temporal relationships within each country's data (autocorrelation) could otherwise distort the results. FGLS was chosen because it efficiently handles these challenges, ensuring that the econometric model accurately captures the relationship between financial inclusion indicators and economic growth, thereby enhancing the reliability of the study's findings.

The F-test, Breusch-Pagan test, and Hausman test were applied to evaluate model fit and specification. Based on these tests, the fixed effects model was selected for the analysis, allowing for a robust examination of the potential link between financial inclusion and economic growth across the selected countries.

## Financial Inclusion Indicators in Arab Countries

Financial inclusion plays a crucial role in fostering economic development, particularly in the Arab region. Key indicators that measure financial inclusion in these countries include the percentage of personal bank account holders in official financial institutions, which demonstrates the basic access to financial services. Another essential metric is access to accounts, highlighting the availability and ease with which individuals can open and use financial accounts. The utilization of bank accounts further illustrates the frequency of account usage for transactions. Additionally, savings in formal financial institutions provide insight into financial security and economic behavior, while borrowing from official financial institutions show access to credit and financing opportunities. These indicators collectively assess the financial integration of populations across Arab nations.

### 1. Personal Bank Account Holders in Official Financial Institutions

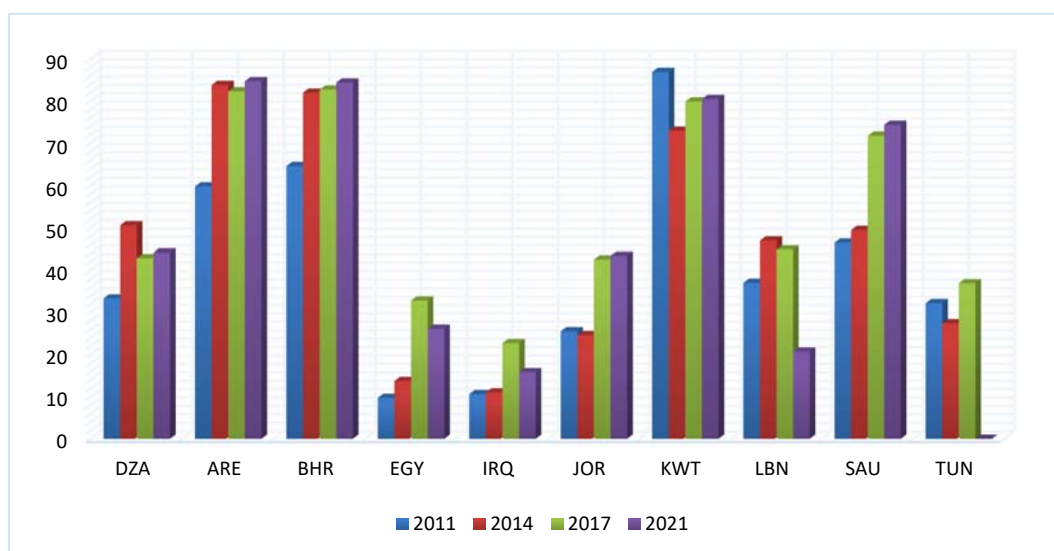
The percentage of personal bank account holders in official financial institutions measures the proportion of individuals with access to formal banking services. It reflects the level of financial inclusion and economic participation. In Arab countries, increasing account ownership is vital for improving access to financial resources and fostering economic growth.

**Table 01.** Personal Bank Account Holders in Official Financial Institutions

	Algeria	UAE	Bahrain	Egypt	Iraq	Jordan	Kuwait	Lebanon	Saudi Arabia	Tunisia
2011	33.3	59.7	64.5	9.7	10.6	25.5	86.8	37.0	46.4	32.2
2014	50.5	83.7	81.9	13.7	11.0	24.6	72.9	46.9	49.4	27.4
2017	42.8	82.2	82.6	32.8	22.7	42.5	79.8	44.8	71.7	36.9
2021	44.1	84.6	84.3	26.1	15.8	43.4	80.4	20.7	74.3	35.7

Source: World Bank Open Data (2024).

**Figure 01.** Trends in Bank Account Ownership Among Arab Countries



Source: World Bank Open Data (2024).

The data on the possession of bank accounts from 2011 to 2021 reveals distinct trends in financial inclusion across several countries. Tunisia's account ownership fluctuated, starting at 32.2% in 2011, dropping to 27.4% in 2014, then rising to 36.9% by 2017, before a slight decrease to 35.7% in 2021. In contrast, Saudi Arabia showed consistent growth, with account ownership rising from 46.4% in 2011 to 74.3% by 2021. Lebanon experienced a mixed trend, with a rise from 37% in 2011 to 46.9% in 2014, followed by a sharp drop to 20.7% by 2021, likely due to the country's financial and political challenges. Kuwait maintained high levels of account ownership, ranging from 86.8% in 2011 to a slight dip at 81.7% in 2021, while Jordan made notable progress, increasing from 25.5% in 2011 to 43.4% in 2021.

Comparing the countries, Tunisia and Lebanon faced greater instability, indicating challenges in sustaining financial inclusion efforts. Saudi Arabia and Kuwait exhibited stronger performance, with steady and high levels of account ownership. Iraq and Egypt started with lower levels, with Iraq growing modestly from 10.6% in 2011 to 15.8% by 2021, while Egypt saw an increase from 9.7% in 2011 to 32.8% in 2017, followed by a decline to 26.1% in 2021. Bahrain and the UAE demonstrated consistently high financial inclusion, with Bahrain rising from 64.5% in 2011 to 84.3% in 2021, and the UAE maintaining account ownership rates in the 80% range throughout the period. Algeria, after a notable rise from 33.3% in 2011 to 50.5% in 2014, showed a slight decline to 44.1% by 2021.

In conclusion, the data highlights diverse outcomes in financial inclusion across the region. Saudi Arabia, Kuwait, Bahrain, and the UAE demonstrated consistent improvement, while Tunisia, Lebanon, and Algeria experienced more fluctuations. These trends reflect varying success in financial inclusion initiatives and the influence of political and economic stability on financial access across the region.

## 2. Access To Accounts in Official Financial Institutions

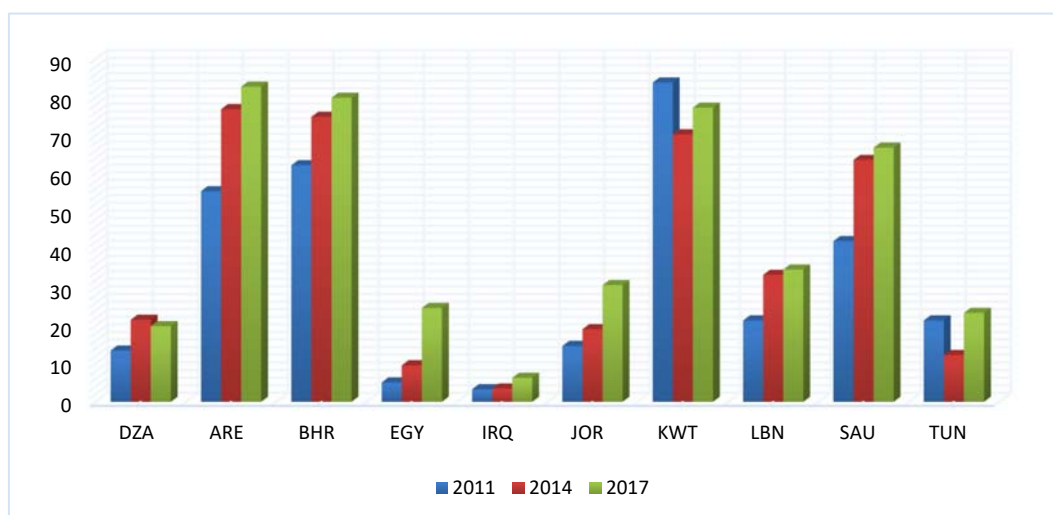
Access to accounts in official financial institutions enhances the ease with which individuals can open and maintain financial accounts. It indicates the availability of banking services and infrastructure, helping to reduce financial exclusion. Improved access is essential for economic empowerment and broader financial inclusion in Arab countries.

**Table 02.** *Index of Access to Accounts in Official Financial Institutions*

	Algeria	UAE	Bahrain	Egypt	Iraq	Jordan	Kuwait	Lebanon	Saudi Arabia	Tunisia
2011	13.5	55.4	62.2	5.1	3.3	14.7	83.9	21.4	42.3	21.4
2014	21.6	76.9	74.9	9.6	3.5	19.1	70.3	33.4	63.6	12.3
2017	19.9	82.8	79.9	24.7	6.3	30.7	77.3	34.8	66.8	23.4

**Source:** World Bank Open Data (2024)

The data highlights trends in access to accounts in official financial institutions across ten countries from 2011 to 2017. Tunisia experienced fluctuations, with access dropping from 21.4% in 2011 to 12.3% in 2014, then increasing to 23.4% in 2017, showing inconsistent progress. Saudi Arabia demonstrated substantial growth, with access rising from 42.3% in 2011 to 66.8% by 2017, indicating significant strides in financial inclusion. Lebanon also showed improvement, increasing from 21.4% in 2011 to 34.8% in 2017, despite political and economic challenges.

**Figure 02.** Accessibility of Financial Accounts in Arab Countries

Source: World Bank Open Data (2024)

In comparison, Kuwait maintained high levels of access, starting at 83.9% in 2011 and stabilizing at 77.3% in 2017, with only minor dips in between. Jordan more than doubled its access rate, from 14.7% in 2011 to 30.7% in 2017, reflecting strong improvements in financial outreach. Iraq's progress was slow, rising from 3.3% in 2011 to just 6.3% by 2017. Egypt showed notable growth, from 5.1% in 2011 to 24.7% in 2017. Bahrain and the UAE consistently performed well, with Bahrain increasing from 62.2% to 79.9%, and the UAE from 55.4% to 82.8% over the same period. Algeria saw an initial rise from 13.5% in 2011 to 21.6% in 2014, followed by a slight decline to 19.9% in 2017.

In conclusion, the data reveals varying progress in financial inclusion. Saudi Arabia, Bahrain, and the UAE showed consistent growth, reflecting successful initiatives. Jordan and Egypt made significant advancements, while Lebanon and Kuwait experienced moderate but stable improvements. Tunisia, Algeria, and Iraq, however, displayed slower or inconsistent progress, highlighting the need for further efforts in these regions.

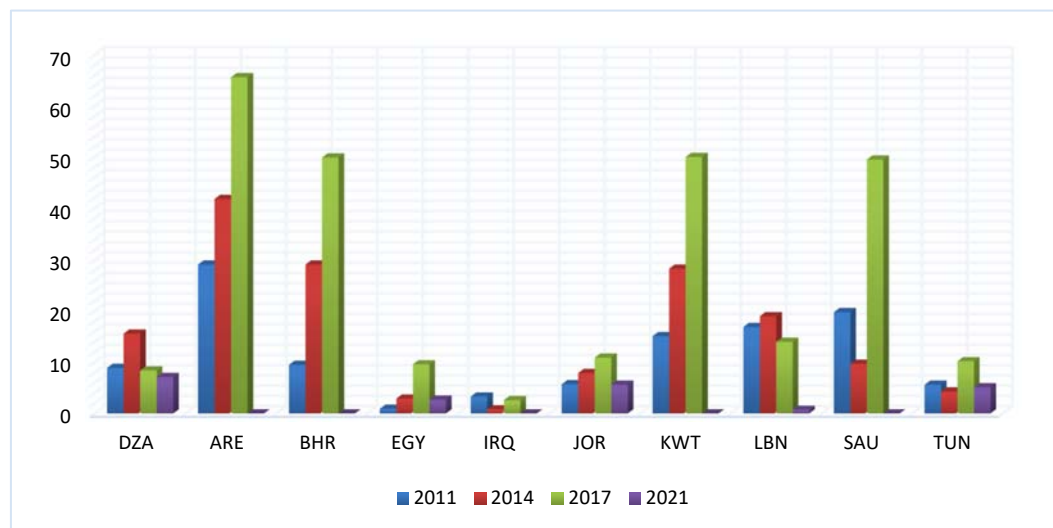
### 3. The Use of Bank Accounts

The use of bank accounts measures how frequently individuals engage in financial transactions such as deposits, withdrawals, or payments through official financial institutions. This indicator provides the practical integration of banking services into daily life. In Arab countries, increasing account usage is key to enhancing financial literacy and fostering economic stability.

**Table 03.** The Indicator of the Use of Bank Accounts

	Algeria	UAE	Bahrain	Egypt	Iraq	Jordan	Kuwait	Lebanon	Saudi Arabia	Tunisia
2011	8.9	29.1	9.5	0.9	3.3	5.7	15.1	16.9	19.8	5.6
2014	15.6	41.8	29.1	2.9	0.8	7.9	28.3	19.0	9.7	4.3
2017	8.4	65.6	49.9	9.6	2.6	10.9	50.0	14.0	49.5	10.2
2021	7.1	-	-	2.7	3.2	5.6	-	0.7	-	5.1

Source: Source: World Bank Open Data (2024).

**Figure 03.** Usage Frequency of Bank Accounts in Selected Arab Countries

**Source:** World Bank Open Data (2024)

The data reveals varying patterns in the use of bank accounts across the observed countries from 2011 to 2021. Tunisia displayed an inconsistent trend, with account usage fluctuating over the years. Saudi Arabia experienced substantial growth, peaking in 2017, reflecting successful financial inclusion efforts. In contrast, Lebanon saw an initial increase, followed by a sharp decline to nearly negligible levels by 2021, likely due to economic instability. Kuwait showed steady growth, reaching its highest point in 2017, while Jordan demonstrated moderate progress, though account usage slightly decreased by 2021. Iraq remained relatively stagnant, with minimal usage throughout the observed period, likely due to political instability. Egypt saw a rise in account usage until 2017, but a notable decline followed. Bahrain and the UAE showed strong performance, with consistent increases in account usage until 2017, though data for 2021 is unavailable. Algeria, similar to Tunisia, experienced fluctuations, with usage rising at certain points but declining again later on.

In comparison, countries like Saudi Arabia, Kuwait, and the UAE showed strong and steady growth in bank account usage, highlighting effective financial inclusion strategies. Jordan and Egypt also made moderate progress, though both experienced declines by 2021. Conversely, Lebanon and Iraq struggled with limited or declining account usage, reflecting the challenges of economic and political instability. Tunisia and Algeria showed inconsistent patterns, with usage rising at certain points but declining again later on.

In conclusion, the data demonstrates mixed outcomes in financial inclusion efforts across the region. While countries like Saudi Arabia, Kuwait, and the UAE made significant advancements in increasing bank account usage, others, particularly Lebanon and Iraq, faced setbacks or stagnation. These trends highlight the varied success of financial inclusion initiatives and the influence of broader socio-economic conditions on account usage in these regions.

#### 4. Savings in Formal Financial Institutions

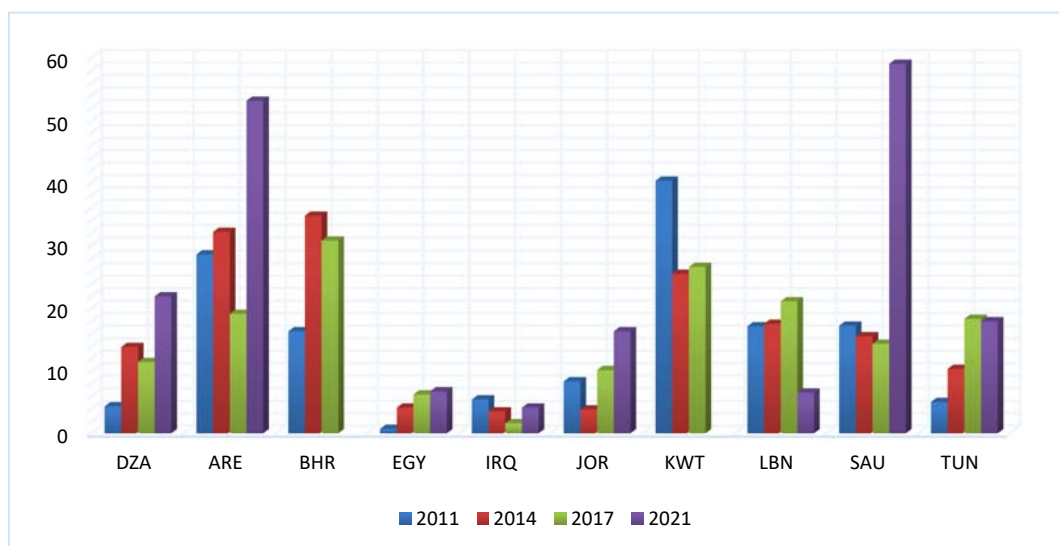
Savings in formal financial institutions track the percentage of individuals who securely store their funds in official banking systems. This indicator reflects financial security and long-term planning. In Arab countries, promoting savings in formal institutions is crucial for strengthening economic resilience and fostering personal financial growth.

**Table 04.** *The Index of Saving in Official Financial Institutions*

	Algeria	UAE	Bahrain	Egypt	Iraq	Jordan	Kuwait	Lebanon	Saudi Arabia	Tunisia
2011	4.3	28.6	16.3	0.7	5.4	8.3	40.3	17.1	17.2	5
2014	13.8	32.1	34.7	4.1	3.5	3.8	25.5	17.5	15.5	10.3
2017	11.4	19.1	30.7	6.2	1.6	10.1	26.6	21.1	14.3	18.3
2021	21.9	53.1	-	6.7	4.1	16.3	-	6.5	59	17.9

Source: World Bank Open Data (2024).

**Figure 04.** *Savings Behavior in Formal Financial Institutions Across Arab Countries*



Source: World Bank Open Data (2024)

Table 04 and Figure 04 present the savings index in official financial institutions across various countries from 2011 to 2021, revealing significant variations in savings behavior influenced by socio-economic conditions. In 2011, Kuwait led with the highest savings index at 40.3%, followed by the UAE at 28.6%, and Saudi Arabia at 17.2%, reflecting strong savings cultures and the high-income levels among citizens in these countries. On the lower end, Egypt 0.7% and Algeria 4.3% exhibited weaker savings behavior, likely due to economic challenges or limited access to financial services.

By 2014, there were notable fluctuations across countries. Bahrain saw a substantial rise from 16.3% to 34.7%, while Kuwait experienced a sharp decline to 25.5%. Tunisia's savings index increased from 5% to 10.3%, showing improvement in financial inclusion, while Egypt made a modest recovery, rising to 4.1%. These variations reflect differing impacts of economic policies and reforms on savings behavior.



In 2017, Tunisia and Lebanon continued their upward trends, with Tunisia reaching 18.3% and Lebanon 21.1%. However, savings in Saudi Arabia and Kuwait declined further, and the UAE and Bahrain also saw decreases compared to 2014. Egypt's savings index showed slight improvement to 6.2 %, possibly due to latest macroeconomic reforms. By 2021, Saudi Arabia's index reached an impressive 59%, signaling a robust financial system, though data were missing for Kuwait and Bahrain. Lebanon's index dropped drastically to 6.5%, likely due to its ongoing economic crisis, while Tunisia, Jordan, and Algeria showed stability or slight improvements.

In conclusion, the savings index data reveal diverse trends across countries, with Saudi Arabia and the UAE showing significant progress in financial inclusion, while Lebanon and Iraq faced notable struggles. Economic stability, policy reforms, and improved access to financial services are key factors that have shaped the savings behavior across the region.

## 5. Borrowing from Official Financial Institutions

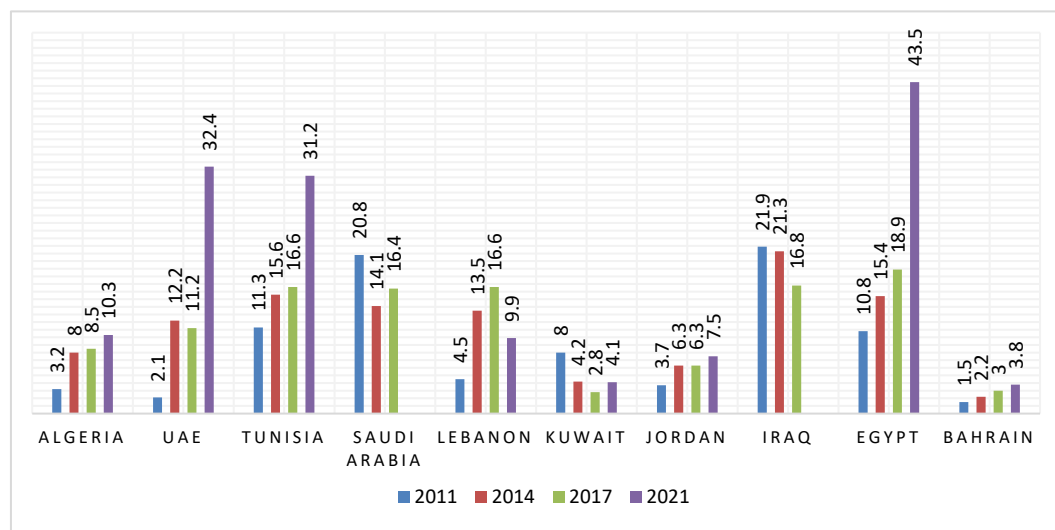
Borrowing from official financial institutions measures the extent to which individuals access credit through formal banking channels. This indicator reflects the availability of financing for personal or business needs. In Arab countries, increasing access to borrowing supports economic development by enabling investments and fostering entrepreneurship.

**Table 05.** *Index of Borrowing from Official Financial Institutions*

	Algeria	UAE	Bahrain	Egypt	Iraq	Jordan	Kuwait	Lebanon	Saudi Arabia	Tunisia
2011	1.5	10.8	21.9	3.7	8.0	4.5	20.8	11.3	2.1	3.2
2014	2.2	15.4	21.3	6.3	4.2	13.5	14.1	15.6	12.2	8.0
2017	3.0	18.9	16.8	6.3	2.8	16.6	16.4	16.6	11.2	8.5
2021	3.8	43.5	-	7.5	4.1	9.9	-	31.2	32.4	10.3

Source: World Bank Open Data (2024).

**Figure 05.** *Borrowing Trends from Official Financial Institutions in Arab Countries*



Source: World Bank Open Data (2024).

The data on borrowing from official financial institutions from 2011 to 2021 reveals diverse trends across several countries, influenced by economic conditions, financial access, and credit policies. In 2011, Kuwait had the highest borrowing index at 20.8 %, followed by Bahrain at 21.9%, indicating strong borrowing activity in these countries. Lebanon 11.3% and Iraq 8 % also showed relatively high borrowing rates, while Algeria 1.5%, Tunisia 3.2%, and Egypt 3.7 % recorded much lower levels, likely reflecting limited access to credit or less developed financial infrastructure.

By 2014, borrowing increased in most countries, with Saudi Arabia rising significantly to 12.2 % and Jordan following closely at 13.5 %, both signaling improved credit access. Tunisia saw a notable jump to 8 %, while Kuwait's index declined to 14.1%, indicating reduced borrowing activities. Algeria and Iraq continued to show low borrowing levels, with only slight improvements. In 2017, Lebanon, Jordan, and the UAE experienced consistent growth, with Lebanon and Jordan both reaching 16.6 %, while the UAE increased to 18.9 %, reflecting rising reliance on financial institutions. Kuwait rebounded to 16.4% after its 2014 dip, while Iraq's borrowing index decreased slightly, likely due to ongoing economic instability.

By 2021, significant developments occurred, particularly in Saudi Arabia, where borrowing surged to 32.4%, and Lebanon's index jumped to 31.2% despite the country's economic challenges. The UAE saw the most substantial increase, reaching 43.5%, indicating strong financial activity, while Tunisia's borrowing continued to rise to 10.3%. Missing data for Kuwait and Bahrain limit analysis for these countries. Algeria's borrowing index remained low at 3.8%.

Overall, the data shows increased credit access in countries like Saudi Arabia, Lebanon, and the UAE, but also persistent disparities in borrowing levels, with Algeria and Iraq lagging behind. This underscores the divergent pace of financial inclusion and credit expansion across the region, influenced by a range of factors including economic growth, regulatory reforms, variations in banking culture, and the prevailing types of financial institutions) whether conventional or Islamic) shaped by religious and cultural consideration.

### The Impact of Financial Inclusion of Economic Growth in Arab Countries 2011-2022

This study employs cluster analysis on Financial Inclusion indicators for Arab countries. The analysis encompasses the following variables:

- **X1:** Index of adult individuals owning bank accounts in official financial institutions.
- **X2:** Index of access to accounts in official financial institutions.
- **X3:** The index of bank account usage.
- **X4:** Savings index in official financial institutions.
- **X5:** Index of borrowing from official financial institutions.
- **X6:** Indicator of individuals owning debit cards issued by financial institutions.
- **X7:** Indicator of individuals owning credit cards issued by financial institutions.

The analysis was conducted for the following countries: Algeria, Bahrain, Egypt, Iraq, Jordan, Kuwait, Lebanon, Saudi Arabia, Tunisia, and the UAE. The detailed results are presented in the following table.

**Table 06.** Classification of Countries According to the Highest and Lowest Value of Financial Inclusion Indicators

Indicators	X1	X2	X3	X4	X5	X6	X7
Lowest value	Iraq	Iraq	Iraq	Iraq	Iraq	Iraq	Iraq
Highest value	Bahrain	UAE	UAE	Bahrain	UAE	Bahrain	UAE

**Source:** World Bank Open Data.

It appears from the above table that the United Arab Emirates and Bahrain occupy the top of the Arab countries in their application of financial inclusion according to the selected indicators, while Iraq is in the last ranks among the Arab countries selected in their application of financial inclusion.

## 1. Cluster Analysis of Financial Inclusion Indicators

Cluster analysis of financial inclusion indicators provides a powerful tool for identifying patterns and grouping countries based on their financial inclusion characteristics. By analyzing key indicators such as personal bank account ownership, access to financial accounts, usage of banking services, savings behavior, and borrowing trends, this method allows for a deeper understanding of how different nations in the Arab region compare and contrast. This approach helps policymakers target interventions more effectively by identifying clusters of countries with similar financial inclusion profiles, guiding efforts to improve access to and use of financial services across the region.

### 1.1. Testing The Normal Distribution of Data

It is important to verify in advance that the selected measurements and indicators follow a normal distribution. Several statistical tests can be used for this purpose, and in this case, the Kolmogorov-Smirnov test was applied. The results are presented in the table 07:

**Table 07.** Results of the Kolmogorov-Smirnov Test

One-Sample Kolmogorov-Smirnov Test		x1	x2	x3	x4	x5	x6	x7
N		10	10	10	10	10	10	10
Normal Parameters <sup>a,b</sup>	Mean	53,88	44,66	27,07	15,94	11,71	41,94	14,67
	Std. Deviation	22,74	28,87	23,57	9,015	6,16	27,95	14,40
Most Extreme Differences	Absolute	0,255	0,234	0,310	0,103	0,276	0,204	0,200
	Positive	0,255	0,234	0,310	0,093	0,122	0,204	0,200
	Negative	-0,183	-0,179	-0,229	-0,103	-0,276	-0,158	-0,186
Kolmogorov-Smirnov Z		0,807	0,739	0,981	0,326	0,874	0,646	0,633
Asymp. Sig. (2-tailed)		0,533	0,645	0,291	1,000	0,429	0,798	0,818

**Source:** SPSS Outputs.

From the results shown in table 07, it is evident that the chosen indicators for the study follow a normal distribution, as indicated by the Kolmogorov-Smirnov Z values, which are all less than the critical value. Furthermore, the probability values (Asymp. Sig. (2-tailed)) for all indicators exceed 0.05, further confirming the acceptance of the assumption that the data follow a normal distribution.

### 1.2. Presentation and Analysis of Results

The statistical software SPSS25 was used to perform cluster analysis on a group of Arab countries, applying variables related to financial inclusion using the Hierarchical Clustering method. Based on this approach, the following results were obtained:

▪ *Proximity Matrix*

The proximity matrix was derived using the clustering method based on the squared Euclidean distance. The results are summarized in the table below:

**Table 08.** *The Results of the Proximity Matrix*

Case	Proximity Matrix									
	Correlation between Vectors of Values									
	1:dza	2:bhr	3:egy	4:irq	5:jor	6:kwt	7:lbm	8:sau	9:tun	10:are
1:dza	1,000	,811	,931	,937	,887	,839	,940	,772	,934	,686
2:bhr	,811	1,000	,931	,630	,852	,965	,867	,982	,656	,929
3:egy	,931	,931	1,000	,828	,968	,940	,965	,910	,825	,826
4:irq	,937	,630	,828	1,00	,797	,699	,824	,615	,890	,579
5:jor	,887	,852	,968	,797	1,000	,843	,951	,838	,769	,696
6:kwt	,839	,965	,940	,699	,843	1,000	,850	,961	,751	,931
7:lbm	,940	,867	,965	,824	,951	,850	1,000	,802	,862	,696
8:sau	,772	,982	,910	,615	,838	,961	,802	1,000	,595	,947
9:tun	,934	,656	,825	,890	,769	,751	,862	,595	1,000	,527
10:are	,686	,929	,826	,579	,696	,931	,696	,947	,527	1,000

**Source:** SPSS Outputs.

From the above table, it can be observed that the smallest distance, indicating the highest similarity in financial inclusion indicators, is between Tunisia and the United Arab Emirates (0.527). Conversely, the largest distance (0.982) is between Saudi Arabia and Bahrain, highlighting the greatest divergence in financial inclusion indicators between these countries.

▪ *Distribution of Group Members (Agglomeration Schedule)*

The agglomeration schedule provides insights into how countries are grouped based on their financial inclusion indicators through hierarchical clustering. The clustering process follows the square of the Euclidean distance method, and the results are outlined in the following table:

**Table 09.** *The Results of the Agglomeration Schedule*

Stage	Agglomeration Schedule					
	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	2	8	,982	0	0	3
2	3	5	,968	0	0	4
3	2	6	,963	1	0	6
4	3	7	,958	2	0	8
5	1	4	,937	0	0	7
6	2	10	,936	3	0	9
7	1	9	,912	5	0	8
8	1	3	,851	7	4	9
9	1	2	,759	8	6	0

**Source:** SPSS Outputs.

From the table, we observe that in the initial step, Saudi Arabia (8) and Bahrain (2) were grouped together with a Euclidean distance of 0.982, indicating the largest distance between them. In step 3, Kuwait (6) joins this group, with a linkage coefficient of 0.963. In step 6, the United Arab Emirates (10) is added to the same group with a distance of 0.936. Finally, in step 9, Bahrain (2) is linked with Algeria (1) at a distance of 0.759,

completing the clustering process. This hierarchical approach highlights how countries are progressively combined into groups based on their financial inclusion characteristics.

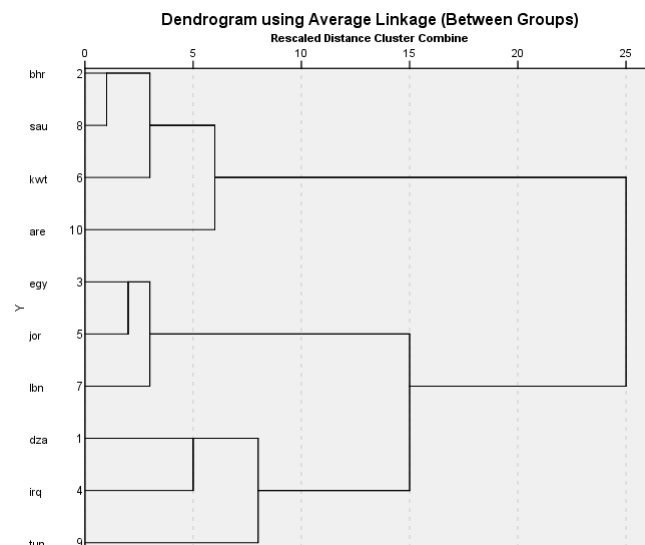
▪ *Distribution of Vocabulary as Members of Groups (Cluster Membership)*

**Table 10.** *Distribution of Vocabulary as Members of Groups (Cluster Membership)*

Case	Cluster Membership		
	Clusters 4	Clusters 3	Clusters 2
1:dza	1	1	1
2:bhr	2	2	2
3:egy	3	3	1
4:irq	1	1	1
5:jor	3	3	1
6:kwf	2	2	2
7:lbl	3	3	1
8:sau	2	2	2
9:tun	4	1	1
10:are	2	2	2

Source: SPSS Outputs.

**Figure 06.** *Hierarchical Clustering Dendrogram of Arab Countries*



Source: SPSS Outputs.

From the above table and figure, it can be observed that Algeria and Iraq consistently belong to the first group when the countries are divided into four, three, or two clusters. Bahrain, Kuwait, Saudi Arabia, and the United Arab Emirates are categorized into the second group across all divisions, whether into four, three, or two groups. Egypt, Jordan, and Lebanon are assigned to the third group when divided into four or three groups, but they merge into the first group when only two groups are considered. Finally, Tunisia belongs to the fourth group when divided into four clusters, but joins the first group when the countries are grouped into three or two clusters.

## 2. Econometric Study of Variables

This section delves into a detailed econometric analysis to understand the relationships between specific variables over a defined period. This section is structured to provide a comprehensive framework for the study, starting with the presentation of the study model, which outlines the theoretical foundation and chosen econometric approach. The following subsections introduce the study community and period, describing the scope and temporal framework of the research. Additionally, the study variables are specified to clarify the key indicators analyzed and their expected impacts. The analysis concludes with a presentation of the study results, including a diagnostic evaluation of the Random Effects Model to ensure its robustness and reliability in explaining the observed data patterns.

### 2.1. Presenting the Study Model:

This study aims to measure the impact of financial inclusion indicators on the Economic growth across a group of Arab countries during the period from 2011 to 2021. To achieve this, the following model has been proposed:

$$GDP = \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \beta_4x_4 + \beta_5x_5 + \varepsilon_i$$

### 2.2. Community and Period of Study

#### ▪ *Study Community*

The study sample includes 10 Arab countries, each of which is assigned a specific code and number as follows:

**Table 11.** Countries Represented by the Study Community

Number	Country	Code	Number	Country	Code
1	Algeria	DZA	1	Kuwait	KWT
2	Bahrain	BHR	2	Lebanon	LBN
3	Egypt	EGY	3	Saudi Arabia	SAU
4	Iraq	IRQ	4	Tunisia	TUN
5	Jordan	JOR	5	UAE	ARU

**Source:** Compiled by the Authors.

#### ▪ *Study Period*

The study period was divided into intervals based on the availability of financial inclusion variables, specifically for the years 2011, 2014, 2017, and 2021.

### 2.3. Study Variables

In this study, all variables that represent indicators of financial inclusion are included, alongside a variable representing economic growth. These variables are as follows:

#### ▪ *Dependent Variable:*

**GDP:** Economic Growth, represented by gross domestic product measured at current prices (US Dollar) (unit = million)

#### ▪ *Independent Variables:*

**X1:** The indicator of adult individuals owning bank accounts in official financial institutions is measured by the number of adult individuals (15) years and older who own bank accounts in official financial institutions. (Unit =thousands);

**X2:** Index of access to accounts in official financial institutions this index measures the ability of individuals aged (15) years and older to access financial services in official financial institutions such as credit cards and ATMs. (Unit =thousands);

**X3:** Bank account usage index this indicator measures the number of individuals aged 15 years and over for their use of Financial Services (Unit = thousands);

**X4:** Savings index in official financial institutions, this index measures the number of individuals aged 15 years and over for approaching and saving in official financial institutions. (Unity = thousands);

**X5:** Borrowing index from official financial institutions, this index measures the extent to which individuals aged 15 and over borrow from official financial institutions. (Unity= thousands).

## 2.4. Study Results

Table 12 presents the results of estimating static panel models using the following methods: cumulative regression (Pooled), fixed effects (Fixed), and random effects (Random). To determine the best-fitting model, a series of tests should be conducted, including the following:

1. *F-Test* (for Fixed Effects): To assess whether the fixed effects model is more appropriate than the pooled regression model.
2. *Breusch-Pagan Lagrange Multiplier (LM) Test*: To determine whether the random effects model is preferable to the pooled regression model.
3. *Hausman Test*: To compare the fixed effects and random effects models, determining which one provides a better fit based on the consistency and efficiency of estimators.

These tests will help in selecting the most suitable model for the data and ensure robust and reliable results.

**Table 12.** *Differential Test for the Selection of a Suitable Static Panel Model*

The test	The trade-off between	Calculated value	Probability	Resolution
Fisher	Pooled/Fixed	12,16	0,0000	Fixed
Breusch and Pagan	Pooled/Random	5,80	0,008	Random
Husman	Fixed/Random	23,15	0,0003	Fixed

**Source:** STATA Outputs.

From the above table, it is evident that the best model for estimating the static panel model is the fixed effects model (Fixed), as compared to the pooled model (Pooled). This conclusion is based on the significance of the Fisher statistic, with a probability value at the 1% level, indicating heterogeneity across the cross-sectional units. When comparing the random effects model to the pooled model using the Breusch and Pagan test, the alternative hypothesis was accepted, suggesting that the random effects model is superior to the pooled model. However, when comparing the fixed effects model to the random effects model using the Hausman test, the alternative hypothesis was also accepted, indicating that the fixed effects model is the best choice for estimating the static panel model.

## 2.5. Diagnostic Tests of the Random Effects Model

To ensure the validity and relevance of the random effects model, a series of diagnostic tests were performed, as summarized in the following table:

**Table 13.** *Diagnostic Tests of the Random Effects Model*

The test	Name of the test	Value	Probability
Self-Association	Wooldridge test	80,104	0,000
Heterogeneity of contrast	Wald Test	265,32	0,000
Autocorrelation between syllables	Pesaran CD test	0.970	0,3321

**Source:** STATA Outputs.

From the diagnostic tests in table 13, the Wooldridge test for autocorrelation shows the presence of autocorrelation, as the null hypothesis is rejected due to the probability value being less than 5%. The Wald test for heteroskedasticity indicates no heteroskedasticity problem, as the null hypothesis was accepted due to the probability value being greater than 5%. The Pesaran CD test shows no cross-sectional dependence, as the null hypothesis cannot be rejected.

To address the issues of autocorrelation and cross-sectional dependence, the generalized least squares (FGLS) method was applied to correct the standard errors of the parameters. The results are as follows:

The variable representing the ownership of bank accounts (measured by the number of individuals aged 15 and above who own accounts) has a negative impact on economic development. This indicates that an increase in the ownership of bank accounts does not contribute to GDP growth in the Arab countries, reflecting a negative effect.

The results reveal a positive and statistically significant relationship between the index of access to bank accounts and economic development. This suggests that an increase in access to bank accounts contributes to higher GDP. Access to financial services, such as credit cards and ATMs, plays a pivotal role in fostering financial inclusion, combating poverty, and promoting financial stability. The availability of financial services enhances economic performance, benefiting market efficiency, job creation, and overall economic growth.

Furthermore, the results indicate a direct relationship between the savings index in financial institutions and economic growth. However, there is an inverse relationship between the borrowing index from financial institutions, the use of bank accounts, and economic growth, although these variables are statistically insignificant. The insignificance of the use of bank accounts suggests that this indicator does not have a meaningful impact on economic growth in this context.

## Conclusion

This study aimed to address the research problem concerning the impact of financial inclusion on the economic growth of a sample of Arab countries. The analysis covered basic concepts of financial inclusion, its objectives, importance, and the challenges impeding its implementation. Additionally, the study examined different indicators of



financial inclusion across a sample of Arab countries, particularly focusing on the empirical aspect, where the relationship between financial inclusion and economic growth was assessed. Five financial inclusion indicators were used as independent variables, with gross domestic product (GDP) serving as the dependent variable representing economic growth.

This study identifies financial inclusion as the process of ensuring that all segments of society have timely and affordable access to regulated financial products and services, achieved through both conventional and innovative methods. Financial inclusion is essential in supporting entrepreneurship, particularly for startups, by providing necessary financing and support to develop small and medium-sized enterprises (SMEs), which, in turn, generate business opportunities and create employment.

However, financial inclusion faces significant obstacles in the Arab region, primarily due to underdeveloped financial infrastructure. Limited access to finance is compounded by low competitiveness among financial and banking institutions and high credit concentration rates, which restrict credit availability for individuals and businesses alike.

The study finds that, according to financial inclusion indicators, the United Arab Emirates and other Gulf nations lead in promoting access to financial services, reflecting substantial progress compared to other Arab countries. This research highlights that strengthening financial inclusion is important for economic growth in the region and suggests that overcoming these barriers could greatly improve financial access and foster economic development.

The econometric analysis, utilizing the feasible generalized least squares (FGLS) method, confirmed that access to financial services significantly impacts economic growth, with access to bank accounts emerging as a particularly influential variable. Interestingly, while access to financial services was linked to economic development, other indicators like borrowing and account usage showed weaker or statistically insignificant relationships, suggesting that mere access alone may not guarantee substantial economic gains without supportive policies.

To address the disparities revealed in the study, several recommendations are proposed. First, policies should focus on expanding financial inclusion infrastructure in countries with lower access levels. Developing mobile and digital banking options, particularly in Iraq and similarly underserved areas, could increase accessibility and foster economic participation. Additionally, integrating financial literacy programs and encouraging savings behaviors may boost the effectiveness of financial inclusion efforts, as these factors were found to enhance economic stability.

Further, promoting regional collaboration on financial policy standards could improve regulatory frameworks across Arab countries. By fostering consistency in financial policies and services, Arab nations may achieve a more unified approach to financial inclusion that benefits both advanced and lagging economies.

This study's findings suggest several avenues for future research. Expanding the dataset to include newer indicators of digital financial inclusion, such as mobile banking usage, fintech adoption rates, and the impacts of financial literacy initiatives, could provide a more

nuanced perspective on the evolving role of financial inclusion. Future studies might also benefit from a comparative analysis across other developing regions, as this would reveal whether similar patterns exist in different economic contexts.

Given the non-normal distribution of certain variables, future research could employ non-parametric techniques or variable transformations to improve model fit and robustness. Additionally, analyzing country-specific factors and identifying the socioeconomic and regulatory conditions that foster successful financial inclusion could yield valuable insights for tailoring financial policies. Such tailored approaches will be essential for maximizing the economic benefits of financial inclusion and ensuring equitable growth across the Arab region.

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## The relationship between external factors and economic growth: Differences between the global financial crisis and the COVID-19 pandemic from a Granger causality perspective

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**Abstract.** *The paper investigates the causal relationship between external factors and economic growth in three countries from Central and Eastern Europe and contains a series of complex analyses on the study of typologies of economic crises. The study includes Markov-Switching Autoregressive (MS-AR) models for characterizing business cycles, and the Granger causality technique is used to analyze the relationship between external shocks and economic growth, separately during financial and pandemic crises. The results indicated that, in the case of Romania, the global financial crisis has a longer period of negative growth rates, but a faster recovery from health crisis. It is also noted that the Czech Republic and Hungary have a more stable economic evolution over time. In addition, the causality test indicates unidirectional causality between external factors and the GDP growth rate during financial and pandemic crises.*

**Keywords:** external shocks, economic growth, COVID-19 pandemic, financial crisis, Granger causality.

**JEL Classification:** E17, E32, E37, E58.

## 1. Introduction

The sustainability of economic growth is one of the most discussed topics in the period of economic decline and is also of great importance in the process of managing economic crises. The economic crises have had various causes, a recent example being the economic decline caused by the spread of the SARS-COV2 virus worldwide, which has affected economic activity in an unprecedented way. Thus, the mobility restrictions adopted to combat the spread of the virus have led to the interruption of economic activities in certain sectors of the economy, but also to the slowdown of production processes in all sectors of activity.

One of the most well-known extreme economic events of the last two decades has been the global financial crisis, which has materialized mainly through a decline in the financial sector and its subsequent spread throughout the economy. Therefore, history shows countless causes that can lead to economic recessions, and some of them are very difficult to predict. However, the main challenge is how to manage them, to ensure rapid but sustainable economic growth. However, depending on the type of economic crisis, many factors hinder the recovery process, which do not depend directly on the affected national economy, but on the evolution of the international economy.

The empirical studies of economic cycles and their characteristics are the most common in the literature, but recent literature is not very developed in terms of comparisons between different types of economic crises, nor comparative analyzes of their evolution in terms of external factors and vulnerabilities. Therefore, the recent health crisis favors the comparative study to provide a better understanding of the vulnerabilities in the management process of economic crises, depending on their typology.

It is well known that the great financial crisis has had a major impact on the economic policies and laws related to the bank's lending activities. During the financial crisis, the world economy experienced the most severe economic recession in decades, with hyperinflation and high unemployment rates, balance of payments disequilibrium and a severe external debt burden with long-lasting effects. Furthermore, there was a significant relationship between the external factors and economic growth as there are two possible effects of external debt burden on economic growth. The negative effect that led to the crowding out of private investments and the crowding-in Keynesian effect, which causes a positive multiplier effect on national output. Also, the disruption in the market's supply and demand equilibrium have led to increases in producer and final consumer prices, generating hyperinflation and balance of payments disequilibrium.

Based on this, the paper proposes a series of analyzes to identify the effects of external factors on economic growth rates in several Central and Eastern European countries, depending on the typologies of economic crises identified over the last two decades. The results of the study provide important information about the current economic context regarding the economy's sensitivity to external factors and make a comparison between three strongly correlated economies to identify possible weaknesses that could lead to severe systemic effects.

## 2. Literature review

There is a vast body of literature that studies the business cycles and their characteristics, but only part of it has dealt over time with the analysis of the impact of external factors on economic growth. Ndubuisi (2017) analyzed the impact of external debt on economic growth through several indicators such as external debt, external debt service, external reserves, and exchange rate and found that there is a unidirectional causality between external debt and GDP. It is also mentioned that the relationship between external debt and GDP could be bidirectional, since debt capital adds to capital formation and has a positive impact on economic growth, but also reduces real GDP through capital outflows.

Gómez-Puig and Sosvilla-Rivero (2015) also studied the existence of bidirectional causality between public debt and economic growth and show that the level of debt has a negative effect on economic growth in several European countries. However, they conclude that further research is needed to better understand and quantify the different effects of public debt on short-term and long-term growth, given the importance of policy implications. Feldstein (2014) argues that a low growth rate means lower government revenues, and in times of economic stress, governments may be forced to increase their debt levels to maintain their wealth, to stimulate short-term demand, and to ensure a high long-term growth rate. Wang et al. (2021) studied the relationship between external debt and economic growth and found that an increase in external debt may predict a slowdown in economic growth in the short and medium term. Similarly, Sosa (2008) points out that the external shocks of economic growth are the main factors that can predict the economic fluctuations in Mexico. Therefore, in addition to the study of the determinants of economic crises, in the literature, the analysis of the impact of external factors provides important information on the current economic context and the main weaknesses of the economy, thus helping to manage them more efficiently. The literature confirms the theoretical expectations that external factors can predict the economic fluctuations but does not provide a clear picture of these relationships depending on the type of economic recession, this being particularly important given the specific effects on certain sectors of activity.

The paper proposes a series of analyzes to identify the effects of external factors on economic growth rates, in three Central and Eastern European countries, depending on the typologies of economic crises identified over the last two decades. The main objectives of the research are to identify the typologies of economic crises and to highlight the current economic context regarding the economy's sensitivity to external factors and the potential severe systemic effects.

The work is structured in two interconnected sections. While the first part deals with identifying the phases of economic cycles, the second part uses the initial results to conduct a comparative study on the effects of external factors on economic growth.

## 3. Methodology

The empirical study involves a series of complex analyses on the typologies of economic crises, as well as the determination of external factors that have a significant impact on their management process.

In order to achieve this goal, the data used were seasonally adjusted and extracted from Eurostat's database, in quarterly frequency, from January 2005 to December 2023, for three strongly correlated developing countries from Central and Eastern European, namely the Czech Republic, Hungary, and Romania, to study the generalized correlated evolution of the economy in this geographical area. Table 1 shows the degree of correlation of quarterly economic growth rates between the three economies.

The paper is structured in two main parts. In the first part, we aim to determine the typologies of economic crises, using economic growth rates of the real Gross Domestic Product, to capture the phases of the economic cycle through the transition probabilities. At this stage, one of the most used methods is applied to identify the typologies of economic crises, namely the Markov-Switching model, which involves estimating the probabilities of being situated within two regimes of the economic cycle. This method was developed by Hamilton (1989), who argues that the rate of economic growth follows a first-order autoregressive process, which means that the value at time  $t$  always depends on the value at time  $t - 1$ . The MS-AR (1) model is defined by equation (1).

$$\Delta y_t = \mu_{S_t} + \beta_{S_t} \Delta y_{t-1} + \sigma \varepsilon_t \quad (1)$$

where,  $\mu_{S_t}$  represents the average of the growth rates related to each regime  $S_t$ ,  $\beta_{S_t}$  is the estimated coefficient related to the growth rate from time  $t - 1$ , and  $\sigma \varepsilon_t$  represents the variance of the estimated errors. The estimation of the model generates the transition probabilities, used to define the two time-horizons, which will capture separately the characteristics of the recession periods. After estimating the transition probabilities, they are subjected to filtering (Hamilton, 1989) and smoothing (Kim, 1994) algorithms to eliminate excessive variations. The model estimation was performed using the software program MATLAB, implemented by Engle (2005) for quarterly data series.

In the second part of the paper, we focus on the study of the impact of several external factors on the economic growth rate, such as the foreign producer price index (PPI for EU-27) to study the potential inflation implications, the real exchange rate and external debt to include the external debt burden and balance of payments disequilibrium effects, the foreign interest rate (3 months - EURIBOR) to capture the monetary policy measures in the economic crisis management process, as well as the Gross Domestic Product of the European Union, as a proxy of the foreign output. Methods such as the Augmented Dickey-Fuller Stationarity test (ADF), the Johansen Cointegration test, the Vector Error Correction Model (VECM) and the Granger causality test are applied to determine the relationship between external factors and the growth rate, on each of the two time-horizons.

In the analysis of time series, before applying the cointegration test to determine the short- and long-term dynamics of the variables, an analysis of the stationarity of the analysed variables must be performed. For this purpose, we apply the Augmented Dickey-Fuller (ADF) test. Therefore, to avoid false results, the analysis of the order of integration of all variables uses unit root tests, whose hypotheses are described by equation (2), and the validation of the null hypothesis captures the existence of the unit root.

$$\begin{cases} H_0: \beta = 0 \\ H_1: \beta < 0 \end{cases} \quad (2)$$



Therefore, the Johansen cointegration test is applied to all analysed variables that have the same integration order. Dwyer (2015) describes two types of Johansen cointegration tests with the same conclusion, namely, the maximum eigenvalue test and the trace test.

The trace test has the following hypotheses:

$$\begin{cases} H_0: rank(\Pi) = r_0 \\ H_1: r_0 < rank(\Pi) \leq n \end{cases} \quad (3)$$

where,  $\Pi$  represents the matrix of adjustment parameters and cointegration vectors, estimated based on a vector autoregressive model (VAR),  $r_0$  represents the rank of the matrix  $\Pi$ , and  $n$  represents the maximum number of cointegration vectors. The Johansen test is a test of the null hypothesis of no cointegration against the alternative of cointegration.

Similarly to Ndubuisi (2017), to determine the direction of causality between variables, we use the Granger causality test (Granger, 1969). The test is based on error correction (ECM). Thus, according to the Granger algorithm, there is a causal relationship between external factors and the growth rate only if the values of the external factors can be used to predict future values of growth rates.

The estimation of the model was performed using the EViews econometric software. Therefore, applying the methodology described above, we capture economic relationships that can provide valuable information on the economy's sensitivity to the external factors, both during the global financial crisis and during the health crisis. These may highlight the current state of the economy and directions for economic policy measures in the management process of economic crises.

#### 4. Data and results

To achieve the study objectives, three Central and Eastern European countries were analyzed, whose economic growth rate series are strongly correlated since 2005. Table 1 shows the degree of correlation of quarterly economic growth rates, from January 2005 to December 2023. It can be observed, a strong correlation of 75% between the Czech economy and the other two economies and a correlation of 68.02% between Romania and Hungary. Therefore, the analysis of the three countries can provide valuable information about the generalized correlated evolution of the economy in this geographical area.

**Table 1.** Correlation analysis of Economic growth series

Country	Czechia	Hungary	Romania
Czechia	100.00%	74.85%	75.30%
Hungary	74.85%	100.00%	68.02%
Romania	75.30%	68.02%	100.00%

**Source:** Authors' own research.

Although the systemic effect of the global economic crisis has had a severe impact on the three economies, the measures taken by each of the three countries analyzed, both in the crisis and in the post-crisis period, have resulted in slow and fast economic recoveries, depending on the specifics of the economic crisis. The study consists of two interconnected parts. While the first section provides an overview of the economic cycles of the three

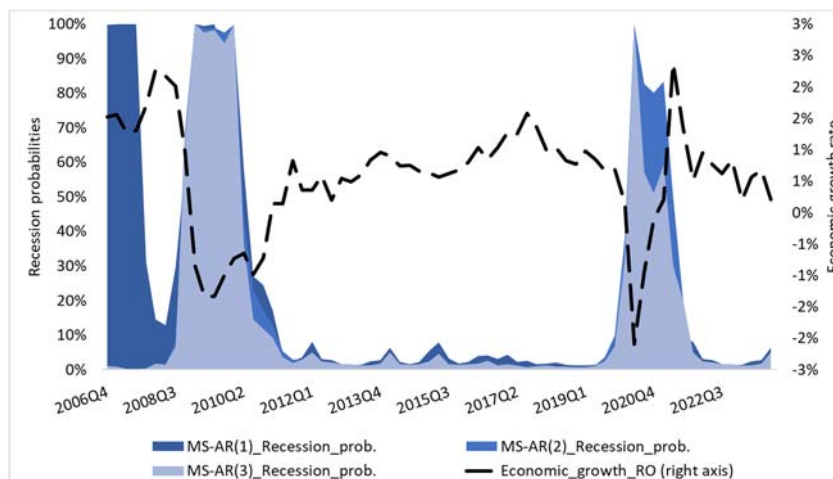
countries, the second section proposes a detailed analysis of the relationship between growth rates and the evolution of external factors, over two time-horizons.

### 1.1. Economic cycle overview

When we talk about forecasting recession periods in the real economy, the phases of business cycles are considered unobservable, and the best-known model for estimating transition probabilities, using unobservable state variables, is the Markov-Switching (MS) model. In general, the estimation of the MS model assumes that the economic growth rate follows a first-order autoregressive process (AR). However, we estimated the MS-AR models up to the third order, as the current value of economic growth may also depend on the values recorded in the last year, to capture the long-term evolution of the economy.

Figure 1 captures the probabilities of entering the recession phase in Romania, for each of the three estimated MS-AR models.

**Figure 1.** Markov-Switching smoothed probabilities – Romania



**Source:** Authors' own research.

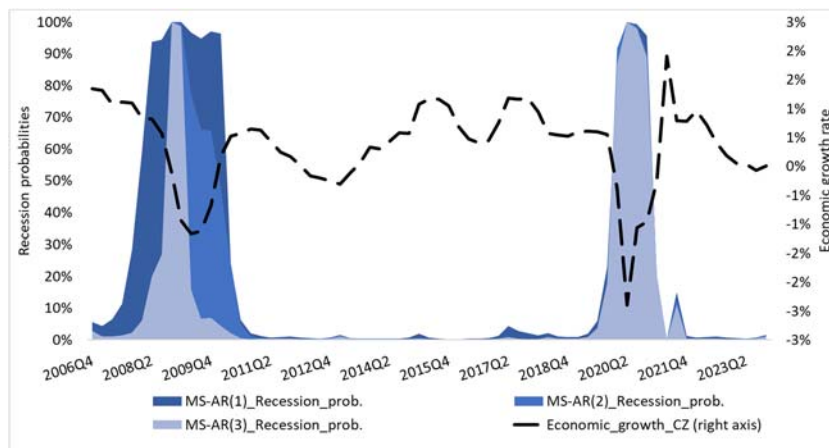
In the case of Romania, there are two periods of concentration, in which all three models capture high probabilities of recession, namely the period of the global financial crisis from 2008-2010 and the recent period associated with the health crisis, starting with the second quarter of 2020. There is also a differentiation between the estimated models, which argues that higher-order-based models provide greater stability of the estimated probabilities. Thus, the MS-AR (1) model identifies a period of short-term instability during 2007, which is not captured in the other models. As for the recent period, the recession probabilities are high, reaching values of about 95% in 2021.

Similarly, Figure 2 captures the probabilities of entering the recession phase in the Czech Republic, for each of the three estimated MS-AR models.

In the case of the Czech Republic, there are also two periods of concentration, in which all three models have a high probability of recession, namely the period of the global financial crisis of 2008-2010 and the recent period associated with the health crisis. Unlike the

Romanian economy, the MS-AR (3) model identifies a shorter period affected by the global financial crisis, being marked by the fast recovery of the economic growth at the end of 2009. However, the recent period had high probability of recession caused by the negative rates at the end of 2020.

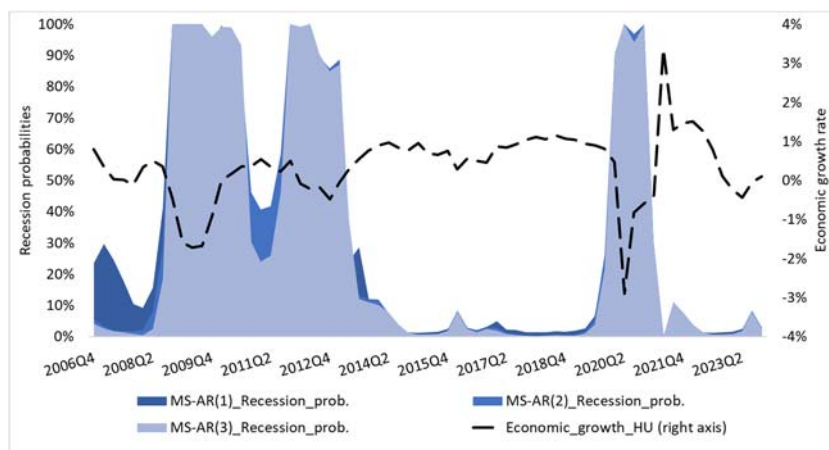
**Figure 2.** Markov-Switching smoothed probabilities – Czechia



**Source:** Authors' own research.

Figure 3 captures the probabilities of entering the recession phase in Hungary for each of the three estimated MS-AR models.

**Figure 3.** Markov-Switching smoothed probabilities – Hungary



**Source:** Authors' own research.

In the case of Hungary, there are also two periods of concentration, in which all three models have a high probability of recession. Furthermore, the sovereign debt crisis is identified since the Hungarian economy was severely affected by it in 2012. However, a lower probability of recession than during the financial and health crisis can be observed.

Also, no significant differences were identified between the estimated models in terms of periods with high probability of recession.

Based on the analysed models, for the three economies, we capture two periods of concentration, representing the financial and health crises. While the Romanian economy is characterized by longer periods with negative rates of economic growth, the economies of the Czech Republic and Hungary indicate faster economic recoveries. Based on these, two equal time-horizons were defined, which separately capture the two extreme events: January 2005 - December 2013, and January 2014 - December 2023, respectively.

### 1.2. Relationship between external factors and economic growth

Methods such as the Augmented Dickey-Fuller Stationary Test (ADF), the Johansen Cointegration Test, the Vector Error Correction Model (VECM) and the Granger causality test were applied to determine the relationship between external factors and the growth rate, on each of the two time-horizons.

In the analysis of the time series, before applying the cointegration test to determine the short- and long-term dynamics of the variables, an analysis was performed to evaluate the stationarity of the variables. The values of the p-value statistic related to the ADF test are above the 5% threshold for the levels, on both time-horizons. Thus, the results of the ADF test show that all the variables are not stationary at levels but become stationary after the application of the first difference, having the same order of integration, respectively I (1).

Subsequently, the Johansen cointegration test was applied, which allows the identification of several cointegration relationships, on each of the two time-horizons. The test does not validate the null hypothesis regarding the lack of cointegration relations at a significance level of 5%. Therefore, we can conclude that there is at least one cointegration relationship between the economic growth rate and external factors, which argues that, regardless of short-term fluctuation, these variables tend to return to the long-term equilibrium.

In the following, to determine the direction of causality between variables, we use the Granger causality test based on the error correction model to study the causal relationship between the evolution of the growth rate and external factors.

The results of the Granger causality test application, in the case of Romania, on each of the two time-horizons are presented in Table 2.

**Table 2.** VEC Granger Causality Test results – Romania

Time horizon	2005 - 2013		2014 - 2023	
	Chi-sq.	Prob.	Chi-sq.	Prob.
D(ECONOMIC_GROWTH_EU27)	11.989060	0.25%	1.719886	18.97%
D(EURIBOR_3M)	2.513166	28.46%	0.511088	47.47%
D(EURRON)	4.708021	9.50%	0.398488	52.79%
D(EXTERNAL_DEBT_RO)	9.412691	0.90%	1.207759	27.18%
D(PPI_EU27)	1.619947	44.49%	0.815193	36.66%

**Source:** Authors' own research.

Thus, according to the Granger algorithm, a causal relationship between external factors and the growth rate exists only if the values of the external factors can be used to predict future values of the economic growth rate.

Table 2 shows only three significant causal relationships in the first time-horizon, while in the recent period the growth rate is not sensitive to changes in external factors, at a significance level of 10%. Therefore, we observe a unidirectional causality relationship between the economic growth rate of the European Union, the EURRON exchange rate, the external debt and economic growth rate of Romania in the first time-horizon, which argues that the three indicators can be used to predict the evolution of the economy as a whole during the time-horizon associated to the financial crisis.

However, the effect of external factors on economic growth in the second time-horizon cannot be completely ruled out, as uncertainties caused by mutations in the viral genome may lead to delayed effects of the economic decline in the financial sector, caused by rising inflation and the need for additional financing sources.

The results of the Granger causality test application on Hungary and Czech Republic, on each of the two time-horizons are presented in Table 3 and Table 4.

**Table 3.** VEC Granger Causality Test results – Hungary

Time horizon	2005 - 2013		2014 - 2023	
	Chi-sq.	Prob.	Chi-sq.	Prob.
Independent variable / Statistic				
D(ECONOMIC_GROWTH_EU27)	10.37068	0.56%	5.36296	6.85%
D(EURIBOR_3M)	2.296047	31.73%	6.303885	4.28%
D(EURRON)	8.325041	1.56%	1.752705	41.63%
D(EXTERNAL_DEBT_RO)	8.265835	1.60%	2.185457	33.53%
D(PPI_EU27)	5.522411	6.32%	2.814411	24.48%

**Source:** Authors' own research.

**Table 4.** VEC Granger Causality Test results – Czechia

Time horizon	2005 - 2013		2014 - 2023	
	Chi-sq.	Prob.	Chi-sq.	Prob.
Independent variable / Statistic				
D(ECONOMIC_GROWTH_EU27)	3.573166	16.75%	0.092759	76.07%
D(EURIBOR_3M)	5.209092	7.39%	4.636419	3.13%
D(EURRON)	1.203848	54.78%	0.043419	83.49%
D(EXTERNAL_DEBT_RO)	0.099572	95.14%	2.542594	11.08%
D(PPI_EU27)	1.163417	55.89%	0.203342	65.20%

**Source:** Authors' own research.

Unlike the Romanian economy, the results of the Granger causality test applied to the Czech Republic and Hungary capture the causal relationship between the external interest rate and the internal economic growth rate, on the second time-horizon, at a significance level of 10%. Moreover, in the first time-horizon, in the case of Hungary, there is a significant causal relationship between the growth rate and most external factors, which captures the more severe effects of the financial crisis, unlike Romania and Hungary, where the factors did not directly impact the evolution of economic growth.

## 5. Conclusions

The empirical study involves a series of complex analyses on the typologies of economic crises, as well as the determination of external factors that have a significant impact on their management process.

The results of the Markov-Switching models capture two periods of concentration, representing the financial and health crises. While the Romanian economy is characterized by longer periods with negative economic growth rates, the Czech Republic and Hungary indicate faster recoveries after economic crises. The Granger causality test also shows a higher sensitivity of economic growth rates to external factors during the first time-horizon, whereas in the second horizon, the causal relationship remains significant only in the case of Hungary and the Czech Republic.

Given the current state of the economy, the recent period is less sensitive to external factors. However, there may be delayed effects of the economic downturn in other sectors, caused by rising inflation and the need for additional financing, which can also be a major source of uncertainty in the economy.

In conclusion, the study assists policy makers to adopt policies that will mitigate the negative effects of external shocks on the economic growth and to reduce the dependence on external debt to finance economic growth, considering the characteristics of economic crisis. However, the results must be taken with caution since they are based on a given econometric methodology with sample dimension limitations, over a certain period and on a predefined set of countries. Additionally, we believe that more research is required to better understand and quantify the different effects of external factors on economic growth in the short and long run, considering the importance of policy implications.

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## **The lasting impact of COVID-19. How the pandemic reshaped human behaviour**

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**Abstract.** *The COVID-19 pandemic has had a profound impact on human behaviour, resulting in enduring effects on societal norms, economic structures, and psychological well-being. This investigation delves into the multifarious repercussions of the pandemic, with a particular emphasis on its enduring impacts on cognitive functioning, social dynamics, and mental health. We have identified critical behavioural patterns, including collective trauma, increased hypervigilance, and social withdrawal, that continue to influence the responses of individuals and communities, through an examination of empirical data and literature. The neurological implications of the "long COVID" phenomenon are examined in conjunction with the broader societal challenges of economic insecurity and disrupted social norms. Moreover, the paper examines the cultural and psychological obstacles that impede the resolution of mental health issues related to the pandemic and suggests practical strategies to promote recovery and resilience. These results emphasize the necessity of recognizing the interconnected psychological, social, and economic dimensions of post-pandemic recovery, and advocating for comprehensive policies and interventions to reduce long-term effects.*

**Keywords:** COVID-19, long COVID, social behaviour, economic impact, resilience.

**JEL Classification:** I12.

## 1. Introduction

The COVID-19 epidemic, which began in 2020, has had a severe psychological impact on people around the world. The peculiar nature of the crisis, which included health concerns, social isolation, economic insecurity, and disruption of daily routines, had a substantial impact on mental health across a wide range of communities.

One of the most significant psychological effects was an increase in anxiety and stress levels. Fear of infection, concern for loved ones, and uncertainty about the future all contributed to widespread anxiety (Torales et al., 2020). The public's continual exposure to pandemic-related news and misinformation contributed to increased stress and uncertainty.

Social isolation caused by lockdowns and physical separating approaches resulted in emotions of loneliness and depression. The decline in face-to-face encounters impacted social support systems, which are critical for mental health (Loades et al., 2020). This isolation proved especially difficult for people who lived alone or have pre-existing mental health issues.

Economic consequences such as job loss and financial insecurity intensified psychological stress. Financial stress is strongly linked to mental health issues as depression and anxiety disorders (Pfefferbaum, North, 2020). The epidemic disproportionately affected vulnerable populations, like as low-income families and marginalized groups, increasing existing inequality.

Healthcare professionals experienced severe psychological difficulties because of rising workloads, infection risks, and ethical issues over resource allocation. According to studies, medical professionals experience high levels of burnout, anxiety, depression, and post-traumatic stress symptoms (Lai et al., 2020).

School closures disrupted children and teenagers' education and social development. In young individuals, emotional and behavioural issues developed by the absence of a consistent routine, reduced physical activity, and limited social interaction (Lee, 2020). The transition to online learning also showed the disparities in access to technology and supportive learning environments.

Older individuals were more sensitive to the pandemic's psychological effects. Concerns about increasing susceptibility to severe illness, combined with isolation from family and community networks, resulted in increased anxiety and depression among the elderly (Armitage, Nellums, 2020).

Access to mental health services was disrupted while healthcare systems prioritized COVID-19 responses. While telemedicine arose as an option, its usefulness was limited for some people due to factors such as technology literacy and internet access (Moreno et al, 2020).

## 2. Literature review

Even today, the psychological consequences of the COVID-19 pandemic are still felt by individuals and communities across the globe. Even though the acute phase of the pandemic has since passed, its enduring effects on cognitive functioning, mental health, and overall



psychological well-being continue. These effects are observed in a variety of demographics and are influenced by a combination of biological, social, and economic factors.

One of the enduring effects of the pandemic is the phenomenon of long COVID, which is characterized by cognitive impairments referred to as "brain fog." This condition can persist for months or even years following infection, and it includes memory issues, concentration difficulties, and reduced cognitive flexibility. The virus's neuroinflammation and alterations in brain function are often cited as the cause of these impairments. Research has demonstrated that even individuals with moderate COVID-19 symptoms may encounter substantial cognitive challenges, which can significantly impact their quality of life and capacity to complete daily tasks (Douaud et al., 2022).

Anxiety, depression, and post-traumatic stress disorder (PTSD) are among the most prevalent mental health issues worldwide, which have been increased by the pandemic. Many individuals have been psychologically affected by the prolonged periods of isolation, uncertainty, and sorrow that have occurred during the pandemic. Healthcare professionals have encountered extraordinary stress, as they have reported high levels of burnout because of the ethical dilemmas surrounding patient care and the increased responsibilities. Numerous individuals in this group are still struggling with their mental health, emphasizing the importance of continued support (Pfefferbaum, North, 2020).

During the pandemic, children and adolescents have encountered distinctive obstacles. Their mental health and development have been significantly impacted by school closures, disrupted routines, and reduced social interactions. Symptoms of depression, anxiety, and behavioural issues have become increasingly common. In addition, research indicates that there has been an increase in disciplinary issues in schools, which is indicative of the more extensive psychological stress that this demographic experienced. The long-term consequences on their emotional and educational development continue to be a pressing concern (Lee, 2020).

Economic stress is another component contributing to the pandemic's long-term psychological impact. A significant number of individuals have experienced increased tension and anxiety because of job losses, financial instability, and the increasing cost of living. Economic uncertainty, heightened by fears of future pandemics or crises, continues to have a negative impact on global mental health (Moreno et al., 2020).

Recent research suggests that even mild COVID-19 infections can result in prolonged cognitive impairments. The University of São Paulo conducted a study that revealed that memory loss and attention deficits persisted for up to 18 months following infection, indicating that the virus may induce long-term neurological changes (Ziegler, 2024).

The investigation comprised 302 participants who were diagnosed with mild, moderate, or severe COVID-19. Cognitive functions, such as attention, memory, processing speed, and intelligence, were evaluated at least 18 months following infection. The results suggested that cognitive impairments were present in all groups, with the severity of these impairments following the intensity of the initial infection. It is important to note that even 11.7% of individuals with moderate symptoms reported ongoing cognitive issues (Serafim et al., 2024).

These results highlight the necessity of acknowledging and addressing the persistent cognitive repercussions of COVID-19, even in cases that were initially regarded as mild. The research encourages the continuous monitoring and support of individuals who are recovering from COVID-19 to improve their cognitive health and overall quality of life.

### **3. Analysis of the neuropathways in the behaviour of the individual**

This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation, as well as the experimental conclusions that can be drawn.

Additionally, there is emerging evidence that the virus has the capacity to infiltrate the central nervous system (CNS) through numerous pathways. One proposed mechanism involves the virus entering the brain through the olfactory nerve, resulting in anosmia (loss of scent), a common early symptom of COVID-19. SARS-CoV-2 has the potential for direct neuro-invasion, as evidenced by the detection of viral particles in the cerebrospinal fluid and brain tissue of infected individuals (Meinhardt et al., 2021).

Sustained neuroinflammation is one of the primary factors contributing to the extended effects of COVID-19. The immune system's excessive response to the virus, which is often referred to as a "cytokine storm," results in the release of elevated levels of pro-inflammatory molecules, like interleukins and tumour necrosis factors. Chronic inflammation in the brain can result from the ability of these cytokines to penetrate the blood-brain barrier. This inflammation disrupts typical brain function and is associated with long-term symptoms, including cognitive impairments, fatigue, and memory loss (Ellul et al., 2020; Hess et al., 2020).

Respiratory distress and hypoxia, which are symptoms of severe COVID-19, can have a detrimental impact on brain function. Neuronal damage can be induced by hypoxia, particularly in regions of the brain that are susceptible to oxygen deprivation. Furthermore, SARS-CoV-2 has been linked to vascular complications, such as micro-vascular damage and blood clot formation, which can result in strokes or other cerebrovascular events, further compromising brain health (Mazza et al., 2023).

COVID-19 has been associated with prolonged neurological and psychological complications, which are collectively known as "long COVID." Symptoms such as impaired concentration, memory loss, and brain fog persist for months following recovery, as reported by patients. These symptoms are suspected to be the result of a combination of persistent neuroinflammation, residual hypoxic damage, and potential autoimmune reactions that are induced by the virus (Smith, 2024).

Evidence of structural brain alterations in individuals recovering from COVID-19 has been obtained through neuroimaging studies. In individuals who had experienced even mild COVID-19, research conducted by the UK Biobank revealed substantial reductions in grey matter in brain regions associated with memory and olfaction. Such changes were observed months following the acute phase, which implies that the virus had lasting impacts on brain structure and function (Douaud et al., 2022; WHO, 2021).

In certain individuals, the brain's plasticity, or its capacity to reorganize and recover after injury, may be slower. The recovery from neuroinflammation, hypoxic damage, or vascular insults is contingent upon factors such as age, pre-existing conditions, and overall health. Symptoms may persist for months or years because of this delayed recovery.

The pandemic's psychological toll, along with the systemic effects of long-lasting illness (such as fatigue and stress), might worsen long COVID symptoms. Cognitive and emotional impairments can result from persistent stress and anxiety, which develops a feedback loop that perpetuates the symptoms over time (Pfefferbaum, North, 2020).

A study conducted by the British Psychological Society has demonstrated that individuals with long COVID-19 symptoms often suffer from psychological distress, including depressive and anxiety symptoms, which are frequently not immediately associated with their previous COVID-19 infection (British Psychological Society, 2021). It can be difficult for individuals to identify the underlying cause of their symptoms due to the overlap between long COVID symptoms and general day to day psychological distress.

According to the Center for Disease Control and Prevention (CDC) [16], the wide range of symptoms associated with long COVID might be mistaken for other health concerns, resulting in underdiagnosis and mismanagement. This emphasizes the necessity of raising public awareness regarding the potential psychological consequences of prolonged COVID-19 to guarantee prompt identification and treatment.

A study published in *The British Journal of Psychiatry* in 2023 investigated the psychological repercussions of long COVID-19, with a particular emphasis on anxiety and depressive symptoms. The researchers discovered that individuals frequently misinterpreted these symptoms as ordinary everyday stress, rather than attributing them to their previous COVID-19 infection. This misattribution was associated with a lack of awareness regarding the psychological consequences of long COVID, which results in delayed treatment and support (Mazza et al., 2023).

Similarly, a 2024 article in *Psychology Today* described the difficulties patients encounter in recognizing psychiatric problems connected with long COVID. The article highlighted the fact that symptoms such as anxiety, depression, and brain fog are frequently misdiagnosed as routine stressors, resulting in inadequate management and underdiagnosis (Smith, 2024). These results accentuate the importance of heightened public education and healthcare provider awareness regarding the psychological effects of long COVID.

#### **4. The Evolution of COVID-influenced societies**

The broader societal patterns in responding to traumatic events, such as the COVID-19 pandemic, can be linked in the collective unawareness of the psychological consequences of long COVID. These patterns are indicative of collective coping mechanisms, gaps in mental health literacy, and sociocultural attitudes toward trauma, which often overlook or minimize the psychological aspects of crises.

Global pandemics and other traumatic events frequently cause a variety of individual and group reactions, ranging from avoidance and denial to overreaction and hypervigilance.

Collective denial is a particularly prominent characteristic. Sociologists have claimed that societies, like individuals, may minimize or disregard the psycho-logical consequences of a crisis to preserve a sense of control and normalcy (Alexander, 2020). Although initially protective, this coping mechanism can result in long-term unaddressed consequences, such as the mental health effects of long COVID.

The general absence of mental health literacy adds still another element causing this unawareness. Many people are unaware of the symptoms of psychological discomfort or the connection between mental health and physical illness. Symptoms such as anxiety, depression, and brain fog may be viewed as unconnected to the infection in cases with long-term COVID, which contributes to a collective underestimation of their importance (Pfefferbaum, North, 2020). During the pandemic, public health messages gave physical safety and infection control priority while comparatively less attention was focused on mental health, thereby potentially resulting in a lack of awareness.

Collective reactions to trauma also reflect cultural views regarding mental health. Acknowledging emotional distress is stigmatized in many countries, especially when it relates to an incident seen as a shared, "external" threat rather than a personal one. This stigma serves to limit the collective awareness of psychological consequences by discouraging individuals from overtly discussing their symptoms or seeking help (Brewin et al., 2020).

Furthermore, societal narratives typically emphasize resilience and recovery following crises, urging the importance of "bouncing back" rather than recognizing the multifaceted and extended nature of trauma recovery. These narratives could force individuals and groups to minimize or overlook residual psychological effects (Bonanno et al., 2011).

Similar collective underestimation of psychological impacts is demonstrated by historical examples of pandemics and other traumatic events. For example, despite considerable psychological suffering during the 1918 influenza pandemic and the post-war era, mental health received minimal attention. These patterns demonstrate how society's focus quickly shifts to recovery and rebuilding frequently leaving the psychological aftermath untreated and unaddressed (Honigsbaum, 2020).

The collective lack of ability or reluctance to address the psychological aftermath of COVID-19 has had a significant impact on people's behaviour today, often in subtle but pervasive ways, as evidenced by the normalization of stress, avoidance of seeking mental health support, societal disengagement, and a lack of proactive measures to address the long-term consequences. These actions derive from insufficient or limited coping mechanisms, cultural stigmas, and limited knowledge about the psychological impact of the pandemic (Mazza et al., 2023).

The normalization of stress and exhaustion is one major behavioural trend. Many people assign symptoms like worry, brain fog, or irritability to the stresses of daily living rather than considering the possibility of a long COVID or unresolved trauma from the pandemic. Social attitudes that downplay psychological suffering and typically portray it as a normal part of a "return to normal" following the pandemic are the root cause of this normalization.

People might therefore keep experiencing severe psychological stress without pursuing intervention (Pfefferbaum, North, 2020).

The persistent disengagement from social interactions is another behavioural effect. At first, social isolation was an essential public health measure, but for some people, it has become a habit. Participation in social and communal activities has decreased because of persistent health risk anxiety that is amplified by psychological symptoms like exhaustion and depression. This disengagement contributes to feelings of loneliness and isolation, resulting in a feedback loop that heightens mental distress (Loades et al., 2020).

Unresolved psychological problems associated with the pandemic have led to higher rates of burnout, absenteeism, and decreased productivity in the workplace. Employees may find it challenging to achieve job requirements if they suffer from cognitive issues, such as memory loss or lack of focus brought on by long COVID. Employers and coworkers who are uninformed of the psychological underlying causes of these issues might interpret them as a lack of effort or dedication, which could damage workplace relationships (Douaud et al., 2020).

Resistance to proactive health measures, such as mental health interventions, is another behavioural trend. Many individuals may refrain from confronting psychological issues due to fear of reliving the trauma of the pandemic or a sense of exhaustion resulting from an extended period of crisis management (Bran et al., 2014). People are unwilling to participate in preventative activities like therapy or public health initiatives that might reduce the long-term impacts of COVID-19 because of this "pandemic fatigue" (Bonanno et al., 2011).

The psychological toll of the pandemic has also increased societal distrust and divisiveness. Long-term stress and uncertainty have made people more defensive and less empathetic, which has led to more conflict in communities. The lack of a coordinated, united approach to the pandemic's psychological impact reflects and exacerbates this fragmentation (Alexander, 2020).

Measures of social distance and enforced isolation during lockdowns disrupt established social norms and habits. Many people experienced loneliness, sadness, and anxiety because of their prolonged isolation, which can create a self-perpetuating cycle of withdrawal. Individuals who have become accustomed to a restricted social life during the pandemic may experience anxiety or find the process of re-engaging with others to be overwhelming, resulting in a preference for solitude (Loades et al., 2020).

People's displeasure in public places, such as shopping malls or crowded areas, is a well-documented psychological effect that has become increasingly evident in the aftermath of the COVID-19 pandemic. This phenomenon can be attributed to a mixture of sensory overload, social reconditioning, and persistent anxiety or frustration resulting from long-lasting isolation during the pandemic.

People's exposure to crowded environments decreased significantly throughout the pandemic. Lockdowns, remote work, and restricted social interactions resulted in more controlled and silent environments for numerous individuals. Upon their return to public

spaces, the clear distinction between these environments and the quiet atmosphere of the pandemic can be overwhelming. Sensory overload, which can result in irritation or discomfort, can be caused by the noise, movement, and simple presence of large crowds in locations such as malls or events (Spence et al., 2021). For individuals who have become accustomed to quieter environments or who are naturally more sensitive to sensory stimuli, this adjustment challenge is particularly intense.

The pandemic disrupted social norms and routines, causing individuals to become less familiar to interacting in public or crowded settings. Prolonged isolation resulted in a decreased capacity to tolerate the unpredictable nature of social environments for a significant number of individuals. The presence of others, the sounds they produce, or their behaviours—elements that were previously taken for granted or seen as normal—may now be perceived as intrusive and irritating. This change is indicative of the necessity for reconditioning to social contexts that were previously regarded as normal but now appear to be invasive and overwhelming (Taylor et al., 2020).

Even though the imminent threat of COVID-19 has diminished, numerous individuals continue to experience anxiety regarding their health and hygiene. Concerns regarding personal space, hygiene, or potential exposure to illnesses may arise in crowded environments. The underlying anxiety might increase annoyance, as individuals may become hyper-aware of the behaviours or proximity of others that they perceive to be risky (Pfefferbaum, North, 2020).

The ongoing stress of adjusting to post-pandemic life can lead to a decrease in emotional reserves, which can lead to increased irritability in situations that necessitate patience or adaptation. For individuals who are still recuperating from pandemic-related burnout or long COVID symptoms such as fatigue and brain fog, noise, queues, or crowded areas in public spaces can be particularly taxing, requiring additional cognitive and emotional energy (Douaud et al., 2022).

Some individuals may experience frustration because of the overcrowded public spaces, which is associated with the loss of a less chaotic, peaceful, quiet setting that was experienced during the pandemic. This resentment can show up as discontentment with individuals and circumstances that symbolize a return to pre-pandemic norms, which some may find overwhelming or unpleasant.

## **5. A roadmap to normality**

Social engagement can be substantially disrupted by cognitive symptoms associated with long COVID, including fatigue, memory difficulties, and brain fog. Due to embarrassment, difficulty concentrating, or fear of being misunderstood, individuals who are experiencing these symptoms may avoid social situations. Physical fatigue can also diminish the energy necessary for socializing, which may contribute to an impulse for isolation (Van der Velden et al., 2021).

Throughout the pandemic, individuals were consistently exposed to messaging that highlighted the significance of maintaining physical distance and the dangers of direct contact to prevent the transmission of the virus. Although protective, these behaviours have

resulted in long-term psychological repercussions. Although vaccination campaigns and decreased infection rates have reduced the immediate threat, numerous individuals continue to experience an elevated sense of vulnerability in overcrowded environments (Georgescu et al., 2021). This is especially true for individuals who have had their loved ones affected, have ongoing health conditions that put them at risk, or have endured severe illness (Taylor et al., 2020).

Hyperawareness of potential health threats frequently induces anxiety in such environments. Research indicates that the pandemic has induced individuals to become more attentive to the hygiene habits, behaviours (such as coughing or sneezing), and proximity of others. This hyperawareness can induce stress or irritation when others fail to comply with the societal expectations of health-conscious behaviour, such as maintaining a safe distance or wearing masks (Pfefferbaum, North, 2020). These reactions are the residual effects of the pandemic's psychological impact on risk perception and personal safety.

This anxiety is made worse by crowded spaces, as they inherently diminish personal control over the environment (Georgescu, 2023). A feeling of being overwhelmed can be generated by unpredictability, movement, and noise. Individuals who continue to associate crowds with increased risk experience the distress of being near strangers that is made worse by their sense of helplessness in managing their exposure (Van der Valden et al., 2021). This perceived lack of safety contributes to a natural aversion to such settings and results in annoyance and dis-pleasure.

Additionally, this anxiety is worsened by the persistent media coverage of COVID-19 variants and other health crises. For certain individuals, even a short encounter with news reports regarding infections or emerging pathogens can instil a sense of anxiety that crowded spaces are still dangerous. The challenges of transitioning back to pre-pandemic norms of social interaction and the long-lasting psychological impact of the pandemic are further highlighted by this "carryover anxiety" (Mazza et al., 2023).

A combination of health concerns and anxiety can be observed in the form of avoidant behaviours or increased anger, discomfort and annoyance in public spaces. Even when public health guidelines are no longer mandatory, individuals may experience feelings of resentment or judgment toward others who appear to disregard them. This may result in social discord, which can further discourage engagement.

Public spaces, such as retail malls, transport hubs, and events, that were previously perceived as neutral or even enjoyable, may now be perceived as threatening or distressing. This change is indicative of the long-term influence of pandemic-induced anxiety on social norms and public behaviour (Branson et al., 2010).

To alleviate these sensations, it is imperative that strategies prioritize the rebuilding of a sense of safety and control in public areas. The psychological advantages of social reintegration and the reduced risks of infection can be promoted through public health campaigns. Interventions, such as mindfulness practices or progressive exposure to crowds, can also assist individuals in rewiring and retraining their emotional responses to these environments.

Many people have become accustomed to pandemic-related behavioural changes, such as virtual communication and diminished in-person interaction. Face-to-face encounters are becoming less necessary due to the convenience of online buying, remote work and digital socialization. Despite being crucial during the pandemic, these tools unintentionally decreased the frequency and importance of face-to-face interactions, making them seem less significant or comfortable (Van der Valden et al., 2021).

A common observation is that the epidemic has caused behavioural and cognitive fatigue, which is a major cause of displeasure, anger and disengagement in public areas. This fatigue reflects both physical and psychological exhaustion caused by the pandemic's accumulated stress and long-term disruptions to regular life.

Cognitive fatigue is a condition in which the brain is too overworked or unable to recuperate sufficiently, resulting in mental exhaustion. Due to long-term stressors like ongoing health concerns, unstable economic conditions, and the sudden transition to new habits like remote work and virtual communication, the pandemic made this situation worse for many people. People felt emotionally drained and exhausted and less equipped to handle demanding or high-stimulation environments, including crowded public areas, because of these stressors taxing cognitive resources (Arenas et al., 2021).

Cognitive exhaustion is especially noticeable during long COVID. Persistent symptoms like "brain fog," trouble focusing, and memory issues are reported by many people. These cognitive impairments are associated with the virus's neuroinflammatory effects and alteration of the brain networks in charge of information processing and attention (Douaud et al., 2022). For people who have been affected, the added sensory and emotional demands of public areas can increase feelings of mental exhaustion and lead to frustration or withdraw.

Behavioural fatigue is the term used to describe a decline in motivation to perform demanding or difficult tasks, frequently brought on by extended stress. Many were under constant pressure to change their lifestyles during the pandemic, including rearranging their work and family schedules and adhering to public health protocols. Van der Velden et al. (2021) observed that this ongoing rearrangement resulted in a depletion of emotional and psychological resilience, which made even routine activities feel burdensome (Bodislav, 2011).

Many find that navigating overcrowded public spaces—including communicating with strangers, managing sensory input, and keeping situational awareness—requires a large amount of emotional energy. When behavioural fatigue is present, these tasks could feel too much to handle, which could cause avoidance or discontentment. Pandemic-induced shifts in social norms, such as increased sensitivity of personal space and hygiene, accentuate this and can make people feel uncomfortable in crowded settings (Spence et al., 2021).

Cognitive and behavioural exhaustion can cause self-perpetuating loops. For example, the reduction of opportunities for social stimulation and positive reinforcement may result in a further deterioration of cognitive and emotional resilience over time, because of the intention to conserve mental energy by avoiding public spaces. Chronic disengagement can



result from this cycle, making it more challenging for people to reintegrate into social settings and resume their pre-pandemic routines.

Irritability and impatience in public spaces are the results of cognitive and behavioural exhaustion. Noise, crowds, or perceived inefficiencies can quickly overwhelm people, which can cause frustration. Additionally, this exhaustion makes it harder to sympathize with others or put up with small frustrations, which makes the social environment less unified and more divided (Pfefferbaum, North, 2020).

It takes both individual and collective efforts to reduce this cognitive exhaustion. Individually, techniques like mindfulness, consistent exercise, and enough sleep can support the recuperation of emotional and cognitive reserves. In terms of society, public spaces can be made less stressful by, for instance, establishing quieter sections, improving signs to lessen confusion, and maintaining cleanliness and order to ease health concerns. Public health campaigns can also be helpful by recognizing the long-term consequences of pandemic fatigue and providing advice on how to gradually reengage in social interactions (Bodislav, Georgescu, 2023).

## 6. Conclusion

The COVID-19 pandemic created significant disruptions and long-lasting changes to daily life, which led to a psychological reaction known as "resentment of lost normalcy." This resentment derives from a sense of loss for pre-pandemic habits, lifestyles, and freedoms, as well as frustration with the difficulties of adjusting to a society in which "normal" feels fundamentally transformed (Mazza et al., 2023).

When faced with disruptions to long-held procedures of living, individuals may experience anger, sadness, or frustration—emotions that frequently appear as resentment against the altered surroundings and its reminders of what has been lost (Pfefferbaum, North, 2020). Being unable to "go back" to a pre-pandemic state worsens this resentment.

Public spaces are now perceived differently because of lingering health concerns or behavioural adaptations, which may stir up frustration and remind people of the disruptions caused by the pandemic (Bodislav et al., 2023). This is particularly true when adapting to new norms feels like a forced compromise rather than a choice (Bonanno et al., 2011).

The pandemic irreversibly changed social norms in addition to disrupting routines. Social separation, masks, and increased health precautions established new standards for public behaviour. Even though many of these measures have been loosened, the psychological impact is still there. Seeing these practices continue in public places can irritate people who link them to pandemic limitations and make them wish for a time when these measures weren't essential (Spence et al., 2021).

In addition, habits developed during the epidemic, such as working from home or avoiding large crowds, have become ingrained in some people. These habits may contrast with societal expectations to resume pre-pandemic behaviours, resulting in internal conflict and increased anger of the perceived loss of personal agency (Van der Valden, 2021).

During the pandemic, social connections were broken, and many people have found it difficult to rebuild them. Some relationships were weakened by the time apart, and disagreements on the pandemic (for example, on vaccines or limitations) generated additional tensions. This difficulty in reestablishing a sense of community contributes to emotions of alienation and resentment, as individuals may believe that the social fabric of their lives has been irreversibly disrupted (Lee, 2020).

Perceptions regarding unequal treatment both during and after the pandemic also cause resentment. Many people believed that the burden of restrictions, job losses, or risks to health was unevenly allocated, which led to dissatisfaction with societal systems or specific groups of people. This perception of unfairness adds to the emotional weight of adjusting to a post-pandemic reality, emphasizing the perceived failure of systems designed to protect and support people during crises (Taylor et al., 2020).

The trauma observed in today's people behaviour originating from the negative experience that the pandemic brought aligns with characteristics of collective trauma, chronic stress trauma, ambiguous loss, and in some cases, post-traumatic stress disorder (PTSD).

There have been widespread behavioural changes because of the pandemic's trauma:

- **Hypervigilance:** An excessive awareness of personal space, hygiene, and health risks in public environments (Taylor et al., 2020).
- **Withdrawal:** Reduced engagement in social activities, avoidance of crowded places, and a growing dependence on virtual communication (Van der Valden, 2021).
- **Resentment and Irritability:** Frustration with societal changes or other people's behaviours that bring back memories of the pandemic.
- **Elevated Emotional Reactivity:** An excessive response to superficial stressors or perceived threats, indicative of unresolved trauma.

These types of traumas show up as behaviours representing unresolved grief, higher alertness, and trouble adjusting to new norms. It is imperative to identify these patterns and resolve their underlying causes to encourage resilience and recovery in the post-pandemic world.

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## Asymmetric effect of monetary policy on stock market performance in the ECOWAS zone: empirical evidence from the NARDL approach

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**Abstract.** *The aim of this study is to analyze the effect of monetary policy on stock market performance in the ECOWAS zone, from 2000 to 2021, using data from three stock exchanges (BRVM, Ghana Stock Exchange and Nigerian Stock Exchange). Applying the NARDL (Nonlinear Autoregressive Distributed Lag) model, the results indicate that monetary policy has an asymmetric effect in the short and long term on stock market performance in the ECOWAS zone. The study revealed that the Nigerian stock market is more reactive to changes in monetary policy than the Ghanaian stock market and the BRVM.*

**Keywords:** Monetary policy, stock market performance, asymmetric effect, NARDL, ECOWAS.

**JEL Classification:** E32, E44, E52, G10.

## 1. Introduction

Stock markets today occupy a central place in the global financial system. They promote the growth of different economic sectors by directing savings from agents in need of financing to those with financing deficits, thus ensuring an optimal allocation of resources (Tripathi and Kumar, 2014). They also act as catalysts for the economic development of countries, which explains the growing interest of researchers in the factors influencing their performance. While financial theory emphasizes firm- and sector-specific factors, a growing body of research highlights the importance of macroeconomic variables, such as monetary policy, inflation, exchange rate, interest rates, and industrial production, in stock market performance (Fama, 1981; Tripathi and Kumar, 2014; Barakat et al., 2016; Omodero and Mlanga, 2019). Among these factors, monetary policy is often considered one of the main variables influencing overall market returns.

It is widely accepted that expansionary monetary policy can improve stock market performance. Indeed, it generally leads to lower interest rates. Given the inverse relationship between lending rates and stock prices, lower interest rates increase stock values, thereby encouraging business investment and enhancing stock market performance (Modigliani, 1971). Conversely, contractionary monetary policy, which increases interest rates, tends to lower stock prices, encouraging investors to raise funds in the stock market, leading to lower demand and stock market value (Waud, 1970). These conflicting predictions about the link between monetary policy and stock market performance have prompted numerous empirical studies using various econometric approaches, leading to mixed results. Some studies have found a positive relationship between these two variables (Jonathan and Oghenebrume, 2017; Marozca, 2020), while others, such as Neri (2002), have found a negative relationship. These divergences highlight the persistent interest of researchers and policy makers in this issue.

Within the Economic Community of West African States (ECOWAS), initiatives have been taken to develop financial markets. For example, in August 2012, a regional meeting in Lagos, bringing together central banks, the West African Bankers Association (WABA) and the private sector, validated the creation of a regional credit risk database and an information sharing system. Furthermore, in 2012 in Accra, it was decided to create a Capital Markets Integration Council composed of leaders of the region's stock exchanges and stock exchange commissions. Regarding monetary policy, the main objective of the region's central banks remains price stability. In the West African Economic and Monetary Union (WAEMU), in accordance with Article 8 of the statutes of the Central Bank of West African States (BCEAO), this objective is a priority, with an inflation target of 2%. In contrast, in Ghana, the Bank of Ghana pursues a policy aimed at maintaining inflation between 6.5% and 10.5%, while maintaining a flexible exchange rate (African Economic Outlook, 2012). The Central Bank of Nigeria, for its part, has maintained price and exchange rate stability since 2001. These initiatives aim to strengthen the performance of

the stock markets in the ECOWAS zone. However, the evolution of the relationship between monetary policy and stock market performance in this area remains ambiguous. From 2000 to 2002, despite an expansionary monetary policy, with an increase in the money supply from 20.3% to 21.5% of GDP, stock market performance declined, as evidenced by the decline in stock market returns from -0.03% to -0.19% and the stock turnover rate from 6.5% to 4.9% (World Bank, 2022). On the other hand, between 2005 and 2008, although monetary policy remained expansionary, stock market performance improved. This period saw the stock market return increase from -0.15% to 0.16%, and the stock turnover rate increase from 6.2% to 16.3% (World Bank, 2022). Between 2008 and 2020, despite a still expansionary monetary policy, with an increase in the money supply to 31.6% of GDP, stock market performance declined again, with a return of -0.11% and a stock turnover rate of 3.4% in 2020 (World Bank, 2022). These data show a contrasting relationship between monetary policy and stock market performance in the ECOWAS zone. Based on this observation, this work questions the effect of monetary policy on the performance of stock markets in the region. The central question of this study is: What is the effect of monetary policy on the performance of stock markets in the ECOWAS zone?

This study therefore analyzes the effect of monetary policy on the performance of stock markets in the ECOWAS zone, focusing on the three main stock exchanges: the Regional Stock Exchange (BRVM), the Ghana Stock Exchange and the Nigerian Stock Exchange. To our knowledge, no previous research has studied this effect asymmetrically in this region while simultaneously focusing on these three stock markets. Previous work (Jonathan and Oghenebrume, 2017; Aladejare et al., 2018; Alugbuo and Chika, 2020) has been limited to analyzing the symmetric effect of monetary policy on stock market performance. Our study attempts to fill this gap by highlighting the asymmetric effect of monetary policy on the performance of these three major stock markets in the region.

The article is structured in six sections. The second presents the literature review, the third details the methodology and variables used, the fourth addresses the data sources and descriptive analysis, the fifth presents the estimation results, and the sixth concludes the study.

## 2. Literature Review

This section reviews theoretical and empirical contributions on the relationship between monetary policy and stock market performance.

### 2.1. Theoretical Contributions

There are differing opinions on the effect of monetary policy on stock market performance. Some argue that monetary policy promotes stock market performance, while others argue

that it tends to diminish it. According to the former's arguments, an expansionary monetary policy leads to a reduction in interest rates. This decrease in rates makes stocks more attractive, which stimulates business investment and, consequently, improves the performance of the stock market (Modigliani, 1971 and Mishkin, 1977). In addition, lower interest rates attract greater capital flows to the stock market, in the hope of higher returns, which also contributes to improving market performance. This view is supported by Fisher's (1930) theory and Fama's (1970) theory of efficient markets.

According to Fisher's theory (1930), stocks, as claims on a firm's real assets, can serve as a hedge against inflation. Therefore, in times of expected inflation, investors could exchange their financial assets for real assets, leading to higher stock returns. Thus, in such a context, stock prices, in nominal terms, should fully reflect expected inflation, and the relationship between these two variables should be positively correlated (Ioannides et al., 2005). From another perspective, Fama's (1970) theory of efficient markets also suggests a positive relationship between monetary policy and stock market performance through the inflation channel. This theory states that information is rapidly incorporated into stock prices. Thus, stock prices should fully reflect all new and available information in a fair manner for all market participants. This allows markets to provide accurate signals for resource allocation, as prices represent the fundamental value of each security, although deviations may occur. Therefore, an increase in the inflation rate should have a positive effect on stock prices, as investors adjust these prices according to inflation (Schöler et al., 2014). As for the latter, they argue that monetary policy has an adverse effect on the performance of stock markets. Unlike the former, they believe that expansionary monetary policy decreases the performance of stock markets due to its inflationary impact. According to Fama and Schwert (1977), there is a negative relationship between inflation and stock prices. Fama (1981) indicates that inflation represents a significant threat to long-term investors because it reduces the returns on financial assets, including stock returns, by disrupting real economic activity. He points out that this negative relationship between inflation and stock returns stems from the positive correlation between stock returns and real activity, as well as the negative correlation between inflation and real activity. They also argue that even tight monetary policies have an adverse effect on stock market performance. According to this perspective, tight monetary policy lowers stock returns. Indeed, the increase in interest rates associated with such a policy leads to a decline in stock prices. This decline encourages investors to sell stocks to raise funds, which further reduces demand and causes prices to fall to a level that could deter new investors (Waud, 1970). As a result, the value of the stock market is reduced. In addition, the increase in interest rates makes bonds more attractive relative to stocks, which also contributes to the decline in stock prices and, consequently, stock returns (Mishkin, 1995). Having presented the theoretical body, we will now discuss the synthesis of empirical research on the effect of monetary policy on stock market performance.



## 2.2. Empirical Contributions

Several empirical studies have been conducted to assess the effect of monetary policy on stock market performance. Positive or negative results have been observed using econometric methods. For example, Nwakoby and Alajekwu (2016) studied the effect of monetary policies on stock market performance in Nigeria between 1986 and 2013. The ordinary least squares (OLS) regression results indicate that monetary policy significantly explains 53% of the variations in the performance of the Nigerian stock market. However, while the monetary policy rate has a non-significant positive effect on the overall stock market index, the lending rate has a positive and significant effect on this index. Alugbuo and Chika (2020) studied the effect of monetary policy on stock market performance in Nigeria from 1981 to 2018 using the ARDL model. The results show that lending interest rate has a positive relationship with all stock indices in the current year. On the other hand, money supply has a negative relationship with stock indices in the current year as well as in the lag periods of the first, second and third year in the short run, but it has a positive relationship with all stock indices in the long run.

Marozca (2020) studied the case of South Africa by analyzing the relationships between stock returns, interest rates, and exchange rates from 1995 to 2019. His results, obtained by the OLS and GARCH (1,1) methods, show a positive and significant relationship between stock returns and interest rates. In Ghana, Adabor and Buabeng (2020) examined the effect of monetary policy on the stock market for the period 1990-2019. Using the Autoregressive Distributed Lag (ARDL) model, they found that the monetary policy rate and the money supply have a negative and statistically significant effect on stock market performance in the long run, while they exert a positive and statistically significant effect in the short run. In contrast to the aforementioned work, other research has focused on larger samples. Lütkepohl and Netšunajev (2018) studied the relationship between monetary policy in the euro area and the stock market using a structural vector autoregressive (SVAR) model. The results indicate that contractionary monetary policy shocks lead to a sustained decline in real stock prices. For their part, Suhaibu et al. (2017) analyzed the relationship between monetary policy and stock market dynamics in 12 African countries for the period 1979–2013, using a panel VAR model.

Their results show that stock markets are positively influenced by respective monetary policies through the interest rate channel. Similarly, Asiedu et al. (2020) examined the dynamics of stock market performance in response to changes in monetary aggregates in 10 African countries from 1993 to 2019, using a vector error correction model (VECM). They found that increases in broad money supply positively improve stock market performance through the interest rate channel.

### 3. Methodology

In this section, we present the empirical model used to assess the effect of monetary policy on the performance of financial markets in the ECOWAS zone. This involves, on the one hand, specifying the model of the study and, on the other hand, defining the variables used.

#### 3.1. Specification of the empirical model and description of variables

The objective of this work is to analyze the effect of monetary policy on the performance of stock markets in the ECOWAS zone. More precisely, this study examines the nature of this effect by focusing on the three main stock exchanges: the Regional Stock Exchange (BRVM), the Ghana Stock Exchange and the Nigerian Stock Exchange. We seek to demonstrate that monetary policy has an asymmetric effect on the performance of stock markets in this region. To our knowledge, this aspect has not yet been explored for stock markets in the ECOWAS zone.

In this study, we use two indicators to assess the stock market performance: stock market return and stock turnover rate, which provide a better understanding of market performance. For the explanatory variables, based on the literature, we include, in addition to monetary policy which is the variable of interest, the inflation rate, economic growth and the exchange rate. Thus, the equations to be estimated can be written as follows:

$$R_{it} = \beta_0 + \beta_1 MP_{it} + \beta_2 INF_{it} + \beta_3 GDP_{it} + \beta_4 ER_{it} + \varepsilon_{it} \quad (1)$$

$$Turnover_{it} = \alpha_0 + \alpha_1 MP_{it} + \alpha_2 INF_{it} + \alpha_3 GDP_{it} + \alpha_4 ER_{it} + \varepsilon_{it} \quad (2)$$

Where,  $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \alpha_0, \alpha_1, \alpha_2, \alpha_3$  et  $\alpha_4$  are the parameters to be estimated.  $\varepsilon_{it}$  is the error term.

The dependent variable  $R_{it}$  represents the stock return and  $Turnover_{it}$  is the stock turnover rate. The stock return is the rate of change of the stock index. It is obtained from the following formula:

$$R = \frac{I_t - I_{t-1}}{I_{t-1}} \quad (3)$$

With  $I_t$  the stock index of period t and  $I_{t-1}$  the stock index of period t-1.

The stock turnover rate (Turnover) is the total value of shares traded during the period, divided by the average market capitalization of the period.

The variable  $MP_{it}$  denotes monetary policy, which can be either expansionary or contractionary depending on its variations. Expansionary monetary policy aims to increase the quantity of money in circulation, while contractionary monetary policy seeks to reduce it. Various indicators can be used to measure monetary policy, such as the central bank policy rate, the money market rate, or the money supply as a percentage of GDP. However, in our study, and due to the unavailability of data, we use the money supply as a percentage of GDP to assess monetary policy. An increase in the money supply indicates an

expansionary policy, while a decrease reflects a contractionary policy. Economists generally agree that a contractionary monetary policy leads to a decrease in stock prices, while an expansionary monetary policy leads to an increase in these prices (Modigliani, 1971). We will test this theoretical hypothesis by postulating a positive effect of expansionary monetary policy and a negative effect of contractionary monetary policy on stock market performance.

The variable  $INF_{it}$  denotes inflation, which is defined as the increase in the general price level. It is measured by the GDP deflator, which is the ratio of nominal GDP to real GDP multiplied by 100. The tax effects hypothesis predicts that inflation has a negative impact on stock market returns. During periods of inflation, firms face increased tax liabilities, which reduce their real profits (Feldstein, 1980). Therefore, rational investors tend to decrease the value of common stocks during these periods to account for the effect of inflation. This decrease in valuation leads to lower stock market returns. Based on this theoretical prediction, we expect a negative effect of inflation on stock market performance.

The variable  $GDP_{it}$  is the GDP growth rate. It is an indicator that measures the economic performance of a country. It is generally accepted that economic growth is favorable to stock market performance. Recessions are bad for stock market profitability, and recoveries are good (Ritter, 2005). We expect a positive effect of economic growth on stock market performance.

The variable  $ER_{it}$  represents the exchange rate, defined as the value of a domestic currency relative to that of another country. It indicates the amount of a foreign currency that can be obtained with one unit of another currency. In general, the exchange rate is the relative price of one currency to another. In this study, we use the real exchange rate to capture this variable. Stock prices decrease when the exchange rate increases, while a decrease in the exchange rate has a positive impact on the stock market (Pilinkus and Boguslauskas, 2009). For this purpose, we expect a negative sign.

### 3.2. Estimation Method

To highlight the asymmetric effects of monetary policy on the performance of stock markets in the ECOWAS region, the study adopts the NARDL model developed by Shin et al. (2014). According to them, the Panel NARDL approach reveals the differences in responses to positive and negative variations. The main advantages of the Panel NARDL model lie in the possibility of examining the non-linear integration relationship between the variables of the model, while estimating the short and long-term effects. It is therefore superior to the Panel ARDL in that it highlights the asymmetric effects of the explanatory variables on the explained variable in the short and long term. Indeed, this approach uses partial sum decompositions to implement non-linearity by examining the possible asymmetric effects in the short and long term. This approach will shed light on the effect of expansionary and restrictive monetary policies on the performance of stock markets in

the ECOWAS zone. It will thus make it possible to simultaneously analyze the effects of the two types of monetary policy on the three main stock markets in the region, in order to determine which contributes the most to improving their performance. This analysis, which previous studies have not highlighted and which the symmetrical relationship does not allow to observe, may be made possible by the NARDL model. Following Shin et al. (2014), the NARDL model is as follows:

$$\Delta y_{it} = \beta_{0i} + \beta_{1i}y_{i,t-1} + \beta_{2i}^+x_{t-1}^+ + \beta_{2i}^-x_{t-1}^- + \sum_{j=0}^{N1} \varphi_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{N2} (\gamma_{ij}^+ \Delta x_{t-j}^+ + \gamma_{ij}^- \Delta x_{t-j}^-) + \varepsilon_{it} \quad (4)$$

Equation (4) can be written in the form of an error correction model as follows:

$$\Delta y_{it} = \tau_i \omega_{i,t-1} + \sum_{j=1}^{N1} \varphi_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{N2} (\gamma_{ij}^+ \Delta x_{t-j}^+ + \gamma_{ij}^- \Delta x_{t-j}^-) + \varepsilon_{it} \quad (5)$$

Where  $\rho$  is the long-term autoregressive coefficient,  $\phi_j$  is the short-term autoregressive coefficient,  $\gamma_j^+$  and  $\gamma_j^-$  are the short-term asymmetric effects of positive and negative variations of  $x$  on  $y$ .

According to equation (5), the models to be estimated are as follows:

$$\begin{aligned} \Delta R_{it} = & \beta_{0i} + \sum_{i=1}^{p-1} \phi_{ij} \Delta R_{i,t-i} + \sum_{t=0}^{q-1} \varphi_{ij}^+ \Delta MP_{i,t-i}^+ + \sum_{t=0}^{q-1} \varphi_{ij}^- \Delta MP_{i,t-i}^- + \\ & \sum_{t=0}^{q-1} \varphi_{ij}^+ \Delta INF_{i,t-i}^+ + \sum_{t=0}^{q-1} \varphi_{ij}^- \Delta INF_{i,t-i}^- + \sum_{t=0}^{q-1} \varphi_{ij}^+ \Delta GDP_{i,t-i}^+ + \\ & \sum_{t=0}^{q-1} \varphi_{ij}^- \Delta GDP_{i,t-i}^- + \sum_{t=0}^{q-1} \varphi_{ij}^+ \Delta ER_{i,t-i}^+ + \sum_{t=0}^{q-1} \varphi_{ij}^- \Delta ER_{i,t-i}^- + \rho R_{i,t-1} + \\ & \theta_{1i}^+ MP_{i,t-1}^+ + \theta_{2i}^- MP_{i,t-1}^- + \theta_{3i}^+ INF_{i,t-1}^+ + \theta_{4i}^- INF_{i,t-1}^- + \theta_{5i}^+ GDP_{i,t-1}^+ + \\ & \theta_{6i}^- GDP_{i,t-1}^- + \theta_{1i}^+ ER_{i,t-1}^+ + \theta_{2i}^- ER_{i,t-1}^- + \varepsilon_{it} \end{aligned} \quad (6)$$

$$\begin{aligned} \Delta Turnover_{it} = & \alpha_{0i} + \sum_{i=1}^{p-1} \omega_{ij} \Delta Turnover_{i,t-i} + \sum_{t=0}^{q-1} \gamma_{ij}^+ \Delta MP_{i,t-i}^+ + \\ & \sum_{t=0}^{q-1} \gamma_{ij}^- \Delta MP_{i,t-i}^- + \sum_{t=0}^{q-1} \gamma_{ij}^+ \Delta INF_{i,t-i}^+ + \sum_{t=0}^{q-1} \gamma_{ij}^- \Delta INF_{i,t-i}^- + \\ & \sum_{t=0}^{q-1} \gamma_{ij}^+ \Delta GDP_{i,t-i}^+ + \sum_{t=0}^{q-1} \gamma_{ij}^- \Delta GDP_{i,t-i}^- + \sum_{t=0}^{q-1} \gamma_{ij}^+ \Delta ER_{i,t-i}^+ + \\ & \sum_{t=0}^{q-1} \gamma_{ij}^- \Delta ER_{i,t-i}^- + \sigma Turnover_{i,t-1} + \delta_{1i}^+ MP_{i,t-1}^+ + \delta_{2i}^- MP_{i,t-1}^- + \\ & \delta_{3i}^+ INF_{i,t-1}^+ + \delta_{4i}^- INF_{i,t-1}^- + \delta_{5i}^+ GDP_{i,t-1}^+ + \delta_{6i}^- GDP_{i,t-1}^- + \delta_{7i}^+ ER_{i,t-1}^+ + \\ & \delta_{8i}^- ER_{i,t-1}^- + \varepsilon_{it} \end{aligned} \quad (7)$$

where:

$$MP_t^+ = \sum_{j=1}^t \Delta MP_{ij}^+ = \sum_{j=1}^t \max(\Delta MP_{ij}, 0) \quad (8)$$

$$MP_t^- = \sum_{j=1}^t \Delta MP_{ij}^- = \sum_{j=1}^t \min(\Delta MP_{ij}, 0) \quad (9)$$

$$INF_t^+ = \sum_{j=1}^t \Delta INF_{ij}^+ = \sum_{j=1}^t \max(\Delta INF_{ij}, 0) \quad (10)$$

$$INF_t^- = \sum_{j=1}^t \Delta PINF_{ij}^- = \sum_{j=1}^t \min(\Delta INF_{ij}, 0) \quad (11)$$

$$GDP_t^+ = \sum_{j=1}^t \Delta GDP_{ij}^+ = \sum_{j=1}^t \max(\Delta GDP_{ij}, 0) \quad (12)$$

$$GDP_t^- = \sum_{j=1}^t \Delta GDP_{ij}^- = \sum_{j=1}^t \min(\Delta GDP_{ij}, 0) \quad (13)$$

$$ER_t^+ = \sum_{j=1}^t \Delta ER_{ij}^+ = \sum_{j=1}^t \max(\Delta ER_{ij}, 0) \quad (14)$$

$$ER_t^- = \sum_{j=1}^t \Delta ER_{ij}^- = \sum_{j=1}^t \min(\Delta ER_{ij}, 0) \quad (15)$$

where,  $PM_t^+$ ,  $MP_t^-$ ,  $INF_t^+$ ,  $INF_t^-$ ,  $GDP_t^+$ ,  $GDP_t^-$ ,  $ER_t^+$  and  $ER_t^-$  represent the positive and negative partial sums of  $MP_t$ ,  $INF_t$ ,  $GDP_t$  et  $ER_t$ , respectively.

$\varphi_{ij}^+$ ,  $\varphi_{ij}^-$ ,  $\gamma_{ij}^+$ ,  $\gamma_{ij}^-$ ,  $\theta_{1i}^+$ ,  $\theta_{2i}^-$ ,  $\theta_{3i}^+$ ,  $\theta_{4i}^-$ ,  $\theta_{5i}^+$ ,  $\theta_{6i}^-$ ,  $\theta_{7i}^+$ ,  $\theta_{8i}^-$ ,  $\delta_{1i}^+$ ,  $\delta_{2i}^-$ ,  $\delta_{3i}^+$ ,  $\delta_{4i}^-$ ,  $\delta_{5i}^+$ ,  $\delta_{6i}^-$ ,  $\delta_{7i}^+$  et  $\delta_{8i}^-$  are the short-term and long-term asymmetric parameters to be estimated.  $\phi_{ij}$  and  $\omega_{ij}$  are the autoregressive parameters.  $\beta_{oi}$  et  $\alpha_{oi}$  are constants.  $\varepsilon_{it}$  is the error term.  $p$  and  $q$  are optimal lags.

The use of the NARDL model first requires the performance of certain econometric tests. First, it is essential to check the stationarity of the series. If the variables are integrated of order 2, this model is not applicable. Then, it is appropriate to test the cointegration between the variables, if the unit root tests indicate a possible long-term relationship. Indeed, a long-term relationship is envisaged when certain variables are integrated of order 1. Thus, if the cointegration tests confirm that the variables are cointegrated, that is, that they maintain a long-term relationship, the NARDL model can be used.

#### 4. Data sources and Descriptive Analysis

This section presents firstly the data sources and secondly the descriptive statistics.

##### 4.1. Data sources and descriptive analysis

The data used in this study are annual and come mainly from the World Bank (WDI, 2023). Due to the unavailability of data, the analysis focuses on 3 stock markets in the ECOWAS zone (the BRVM, the Ghana Stock Exchange and the Nigerian Stock Exchange) and covers the period 2000-2021. Table 1 presents a summary of the variables, their sources and the expected effects.

**Table 1.** Variables, data source and expected variable signs

Variables	Definition of variables	Data sources	Expected signs
R	Stock market performance	WDI (2023)	
Turnover	Stock turnover rate	WDI (2023)	
MP	Monetary policy	WDI (2023)	+/-
INF	Inflation rate	WDI (2023)	-
GDP	GDP growth rate	WDI (2023)	+
ER	Exchange rate	WDI (2023)	-

**Source:** Authors, from literature.

##### 4.2. Descriptive Analysis

Table 2 presents the descriptive statistics of the data. It presents the mean values and the respective standard deviations as well as the minimum and maximum values of the variables used. The mean value essentially indicates the average value of the variable and the standard deviation shows the magnitude of the deviation from the mean value.

**Table 2.** Descriptive statistics of the variables

Variable	Mean	Standard deviation	Min	Max	Observations
R	0.027	0.253	-0.459	1.346	N = 63
Turnover	6.411	5.245	0.873	34.785	N = 63
MP	24.748	6.431	11.300	38.663	N = 63
INF	13.342	12.662	0.686	80.754	N = 63
GDP	4.802	3.211	-4.825	15.329	N = 63
ER	244.896	240.394	0.544	732.397	N = 63

**Source:** Authors, based on World Bank data (2022).

Table 2 shows that the average stock return is 0.027, with a minimum value of -0.459 and a maximum of 1.346. The standard deviation, of 0.253, higher than the average, reflects a high dispersion. Turnover, on the other hand, has an average of 6.411 with a dispersion of 5.245, its minimum value being 0.873 and the maximum of 34.785. Regarding monetary policy, the average is 24.748 with a low dispersion of 6.431, a minimum of 11.300 and a maximum of 38.663. Inflation has an average of 13.342, a dispersion of 12.662, and varies between a minimum of 0.686 and a maximum of 80.754. GDP has an average of 4.802 with a standard deviation of 3.211, a minimum of -4.825 and a maximum of 15.329. Finally, the exchange rate has an average of 244.896, with a significant dispersion of 240.394, a minimum value of 0.544 and a maximum of 732.397. Table 3 also shows the results of the correlation matrix of the different variables.

**Table 3.** Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)
(1)R	1				
(2)MP	-0.003	1			
(3)INF	0.129	-0.140	1		
(4)GDP	0.207	-0.335*	0.263*	1	
(5)ER	-0.231	-0.008	-0.483*	-0.426*	1
Variables	(1)	(2)	(3)	(4)	(5)
(1)Turnover	1				
(2)MP	-0.225	1			
(3)INF	0.046	-0.140	1		
(4)GDP	0.355*	-0.335*	0.263*	1	
(5)ER	-0.345*	-0.008	-0.483*	-0.426*	1

**Note:** \* represents the correlation between variables at the 10% threshold.

**Source:** Authors, based on World Bank data (2022).

Table 3 reveals that inflation and economic growth are positively correlated with stock market returns and turnover, while monetary policy and exchange rate are negatively correlated with these two indicators. In addition, a low correlation between the explanatory variables is observed, suggesting the absence of multicollinearity problem in the models of the study. Thus, all the selected variables will be integrated into the regression.

Following the analysis of descriptive statistics and correlation, in the next section, we will present the results.

## 5. Estimation Results

This section first presents the results of the econometric tests before moving on to those of the estimations.

### 5.1. Econometric tests

The results of the econometric tests in this study mainly include the homogeneity test, the Hausman test, the cross-sectional dependence test, the unit root tests and the cointegration tests. The results of these different tests are shown in Tables 4, 5, 6, 7 and 8, respectively.

**Table 4.** Results of Pesaran and Yamagata (2008) homogeneity test

	Yield	Turnover
Delta	1.662** (0.007)	2.001** (0.045)
adj.	-2.091** (0.037)	-2.518** (0.012)

**Note:** (\*\*) represent the significance level at the 5% threshold.

**Source:** Authors, based on World Bank data (2023).

The results of the homogeneity test indicate that the null hypothesis of panel homogeneity is rejected at the 5% level, as both the delta and adjusted delta statistics are significant at this level. This shows that the panel is heterogeneous, suggesting the presence of specific effects. To test whether these specific effects are fixed or random, we performed the Hausman test, the results of which are presented in Table 5.

**Table 5.** Hausman Test

	Stock market performance	Turnover
Chi2(4)	60.67***	17.63***
(Prob>chi2)	(0.000)	(0.0001)

**Note:** (\*\*) represent the significance level at the 5% threshold.

**Source:** Authors, based on World Bank data (2023).

The results of the Hausman test indicate the presence of fixed effects, with a probability of less than 1%. This leads us to perform the Breusch-Pagan (1980) dependence test. The results of this test are presented in Table 6.

**Table 6.** Results of the interindividual dependency test

	Stock market performance	Turnover
Chi2(3)	3.448	4.636
Prob > chic2	0.327	0.200

**Source:** Authors, based on World Bank data (2023).

The results of the cross-sectional dependence test confirm the inter-individual independence, since the probability exceeds 10%. Consequently, the first-generation unit root tests will be applied to check for the presence of a unit root and determine the order of integration of our series. We performed the unit root test of Choi (2001), the results of which are presented in Table 7.

**Table 7.** *Choi (2001) unit root test*

Variables	Dickey-Fuller		Phillips-Perron		Decision
	Level (0)	Differance (1)	Level	Differance (1)	
R	8.690*** (0.000)	-	8.690*** (0.000)	-	I(0)
Turnover	6.650*** (0.000)	-	6.650*** (0.000)	-	I(0)
MP	-0.460 (0.677)	9.077*** (0.000)	-0.460 (0.677)	9.077*** (0.000)	I(1)
INF	21.397*** (0.000)	-	21.397*** (0.000)	-	I(0)
GDP	0.417 (0.338)	15.346*** (0.000)	0.417 (0.338)	15.346*** (0.000)	I(1)
ER	-0.876 (0.809)	3.294*** (0.000)	-0.876 (0.809)	3.294*** (0.000)	I(1)

**Note:** (\*\*\*) represent the significance level at the 1% level.

**Source:** Authors, based on World Bank data (2023).

The results of the unit root tests indicate that the variables stock return, turnover and inflation are stationary in level, or integrated of order 0. On the other hand, the variables monetary policy, GDP and exchange rate are stationary in first difference, therefore integrated of order 1. This suggests a possible long-run relationship between these variables. We therefore carry out tests to verify the existence of such a relationship. The results of the cointegration tests of Pedroni (1999) and Kao (1999) are reported in Table 8.

**Table 8.** *Cointegration test of Pedron (1999) and Kao (1999)*

	Stock market performance		Turnover	
	Statistic	p-value	Statistic	p-value
<b>Pedroni (1999)</b>				
Modified Phillips-Perron t	-0.525***	0.009	0.363***	0.008
Phillips-Perron t	-9.541***	0.000	5.356***	0.000
Augmented Dickey-Fuller t	-9.196***	0.000	-3.772***	0.0001
<b>Kao (1999)</b>				
Modified Dickey-Fuller t	-0.261***	0.006	-2.910***	0.001
Dickey-Fuller t	-2.066**	0.019	-2.728***	0.003
Augmented Dickey-Fuller t	-1.923**	0.027	-3.025***	0.001
Unadjusted modified Dickey- Fuller	-9.181***	0.000	-4.445***	0.000

**Note:** (\*\*\*) and (\*\*) represent significance levels at the 1% and 5% level, respectively.

**Source:** Authors, based on World Bank data (2023).

The results of the cointegration test show that the probabilities are less than 5%, which leads to the rejection of the null hypothesis of no cointegration relationship. Therefore, a long-run relationship exists between the variables. With the results of the econometric tests being presented, in the following, we will present the estimation results as well as the discussion of these results.

## 5.2. Estimation Results and Discussion

The estimation of the NAR DL model requires the prior verification of asymmetry. Table 9 provides the results of the asymmetry test.



**Table 9.** *Asymmetry Test*

Variables	Long term		Short term		Decision
	Chi2	P-value	Chi2	P-value	
MP	19.51***	0.000	53.08***	0.000	Asymmetry
INF	10.86***	0.001	5.25**	0.021	Asymmetry
GDP	21.46***	0.000	14.33***	0.000	Asymmetry
ER	3.34**	0.007	10.03**	0.004	Asymmetry

**Note:** (\*\*\*) and (\*\*) represent significance levels at the 1% and 5% level, respectively.

**Source:** Authors, based on World Bank data (2023).

As shown in Table 9, the symmetry hypothesis is rejected for both short-run and long-run relationships at the 5% level. Therefore, monetary policy, inflation, economic growth, and the exchange rate have an asymmetric effect on stock market performance. This confirms the choice of the NARDL model. The estimates of the long-run parameters are reported in Table 10 and those of the short-run parameters are presented in Table 11.

**Table 10.** *Estimation results of the NARDL model (Long-term dynamics)*

Variables	Yield	Turnover
<b>MP<sup>+</sup></b>	0.051 *** (0.000)	3.278*** (0.000)
<b>MP<sup>-</sup></b>	-0.107*** (0.000)	-0.941*** (0.000)
<b>INF<sup>+</sup></b>	-0.011** (0.027)	-1.054*** (0.000)
<b>INF<sup>-</sup></b>	0.009* (0.053)	0.884*** (0.000)
<b>GDP<sup>+</sup></b>	0.033*** (0.004)	2.445*** (0.000)
<b>GDP<sup>-</sup></b>	-0.033 (0.100)	0.826*** (0.000)
<b>ER<sup>+</sup></b>	-0.003*** (0.000)	-0.082*** (0.000)
<b>ER<sup>-</sup></b>	-0.001 (0.398)	-3.284*** (0.001)

**Note:** (\*\*\*), (\*\*), (\*) represent the significance level at the 1%, 5% and 10% level, respectively. Probabilities are in parentheses. [+] and [-] are positive and negative changes in the variables, respectively.

**Source:** Authors, based on data from the World Bank (2021).

**Table 11.** *Estimation results of the NARDL (Short-term dynamics) model*

	CEDEAO		BRVM		Ghana Stock Exchange		Nigeria Stock Exchange	
	Rendement	Turnover	Rendement	Turnover	Rendement	Turnover	Rendement	Turnover
<b>E<sub>c</sub></b>	-0.957*** (0.000)	-0.188* (0.095)	-0.844*** (0.000)	-0.003** (0.045)	-1.078 (0.000)	-0.169** (0.021)	-0.950*** (0.000)	-0.39*** (0.000)
<b>ΔMP<sup>+</sup></b>	-0.037*** (0.000)	-0.117* (0.054)	-0.054* (0.058)	-0.155 (0.715)	-0.039 (0.585)	0.246 (0.624)	-0.019*** (0.001)	-0.44*** (0.000)
<b>ΔMP<sup>-</sup></b>	0.068*** (0.000)	1.539*** (0.001)	0.054 (0.440)	0.870 (0.431)	0.090 (0.306)	1.369** (0.043)	0.060*** (0.000)	2.378*** (0.000)
<b>ΔINF<sup>+</sup></b>	0.004 (0.259)	0.125 (0.323)	-0.002 (0.925)	-0.123 (0.759)	0.004 (0.741)	0.207* (0.053)	0.012*** (0.000)	0.292*** (0.000)
<b>ΔINF<sup>-</sup></b>	-0.010** (0.020)	-0.073** (0.045)	-0.014* (0.071)	0.135 (0.262)	-0.001 (767)	0.078* (0.084)	-0.016*** (0.000)	0.007 (0.762)
<b>ΔGDP<sup>+</sup></b>	-0.002 (0.745)	-0.092 (0.733)	-0.011 (0.646)	0.221 (0.584)	0.015 (0.734)	0.134 (0.695)	-0.012 (0.325)	-0.63*** (0.000)

	CEDEAO		BRVM		Ghana Stock Exchange		Nigeria Stock Exchange	
$\Delta GDP^-$	0.042*** (0.000)	0.112 (0.609)	0.047* (0.061)	-0.231 (0.407)	0.036 (0.410)	0.045 (0.884)	0.041*** (0.000)	0.524*** (0.000)
$\Delta ER^+$	-0.011 (0.394)	-0.741 (0.329)	0.001** (0.039)	-0.005 (0.624)	-0.038 (0.907)	-2.258 (0.327)	0.002** (0.027)	0.040*** (0.000)
$\Delta ER^-$	-0.016 (0.298)	-0.529 (0.323)	-0.001 (0.145)	0.011 (0.380)	-0.047 (0.706)	-2.357 (0.465)	-0.046*** (0.000)	-1.60*** (0.000)
<i>Cons</i>	-0.049 (0.129)	-1.285*** (0.001)	-0.064** (0.036)	-0.533 (0.216)	0.012 (0.888)	-1.670* (0.082)	-0.097*** (0.000)	-1.65*** (0.000)

**Note:** (\*\*\*), (\*\*), (\*) represent the significance level at the 1%, 5% and 10% level, respectively. Probabilities are in parentheses. [+] and [-] are positive and negative changes in the variables, respectively.

**Source:** Authors, based on data from the World Bank (2023).

The result shows that the coefficients of the adjustment term are statistically significant at the 1%, 5% and 10% levels in the regressions. This result indicates that the system returns to equilibrium in the event of a shock causing an imbalance. In addition, it reveals a stable long-term cointegration between the variables. The estimates reveal that monetary policy has an asymmetric effect on the long-term performance of stock markets in the ECOWAS region. Indeed, an increase in the money supply has a positive and statistically significant impact at 1% on stock market returns and turnover, which means that an expansionary monetary policy improves the performance of stock markets in this region. Conversely, a decrease in the money supply has a negative effect, also significant at 1%, on these same indicators, suggesting that a restrictive monetary policy harms long-term stock market performance in the ECOWAS region. This asymmetric effect can be explained by the stock price channel in the transmission of monetary policy. According to this mechanism, a restrictive monetary policy causes stock prices to fall, while an expansionary policy causes them to rise (Tobin, 1969). Monetarist theory maintains that when the money supply increases, agents, believing that they have excess liquidity, seek to spend it, particularly on the stock market, thereby increasing the demand for stocks and pushing up prices, which strengthens stock market performance. In addition, an expansionary monetary policy reduces interest rates, making bonds less attractive relative to stocks, which contributes to rising stock prices and improving market performance (Modigliani, 1971). In contrast, a restrictive policy raises interest rates, making bonds more attractive than stocks, which leads to falling stock prices and, consequently, to a deterioration in stock market performance.

The short-run results, as shown in Table 11, show a different asymmetry compared to the long-run results. In the short run, an expansionary monetary policy, characterized by an increase in the money supply, has a negative and statistically significant effect on stock market returns and turnover at the 1% and 10% thresholds, respectively. In contrast, a contractionary monetary policy, leading to a decrease in the money supply, improves stock market performance positively and significantly at the 1% threshold in the ECOWAS region. This seemingly counterintuitive result could be explained by the fact that in the short run, an expansionary monetary policy can be interpreted by investors as a reaction to

difficult economic conditions. To this end, if they consider this policy as an indicator of economic weakness or financial distress, they could respond by selling stocks, which could cause stock prices to decline. Our results contrast with those of Marozca (2020), who showed that money supply has a negative effect on long-term stock market performance in South Africa, while exerting a positive effect in the short term.

The stock market-specific results show that monetary policy has an asymmetric effect on the Nigerian Stock Exchange. Indeed, an increase in the money supply linked to an expansionary monetary policy leads to a decrease in stock returns and turnover, while a decrease in the money supply causes an increase in these indicators. On the other hand, expansionary monetary policy has a positive but insignificant effect on the performance of the Ghana Stock Exchange, while restrictive monetary policy has a positive and significant effect on turnover, but not significant on stock returns. For the BRVM, the results show that the increase in the money supply resulting from an expansionary monetary policy has a negative and significant effect on stock returns, but does not significantly affect turnover. On the other hand, the decrease in the money supply linked to a restrictive monetary policy has a positive, although insignificant, effect on stock returns and turnover. Monetary policy seems to have little influence on the performance of the Ghana Stock Exchange and the BRVM. These results suggest that the Nigerian Stock Exchange is more sensitive to monetary policy changes than the Ghana Stock Exchange and the BRVM. This difference could be attributed to the dynamics of the Nigerian Stock Exchange relative to the other two stock markets.

Regarding the control variables, a decrease in inflation has a negative effect on stock market performance in the short term in the ECOWAS region. However, in the long term, an increase in inflation negatively and significantly affects stock market performance, while a decrease in inflation has a positive effect, which confirms Fisher's (1930) theory that inflation has a positive effect on stock market returns when companies use stocks as a hedge against inflation. Regarding economic growth, in the short term, a decrease has a positive and significant effect on stock market returns, but not a significant effect on turnover. In the long term, an increase in the GDP growth rate improves stock market returns and turnover, while a decrease has a positive and significant effect on turnover. This result corroborates those of Şentürk et al. (2014) highlighted in Turkey. As for the exchange rate, in the long term, an increase has a negative and significant effect on the performance of stock markets in the ECOWAS zone, just like a decrease, which also negatively affects stock markets.

## 6. Conclusion and Policy Implications

This study aimed to analyze the asymmetric effect of monetary policy on stock market performance in the ECOWAS zone, focusing on three stock exchanges in the region. Methodologically, the nonlinear ARDL (NARDL) model was used. The results from the

zone showed that monetary policy has an asymmetric effect in the short and long term on stock market performance in the ECOWAS zone. In the short term, an expansionary monetary policy has a negative and significant effect on stock market performance, while a restrictive monetary policy has a positive and significant effect. However, in the long run, an expansionary monetary policy significantly improves the performance of stock markets, while a restrictive monetary policy influences it negatively. The analysis by stock market revealed that the Nigerian Stock Exchange is more responsive to variations in monetary policy than the Ghana Stock Exchange and the BRVM. In light of these results, the main lessons of this study are as follows. First, the effect of monetary policy on the performance of stock markets in the ECOWAS zone is asymmetric, rather than symmetric. Second, it appears that expansionary monetary policy improves the performance of stock markets only in the long run, while in the short run, it has a negative effect. On the other hand, restrictive monetary policy improves stock market performance in the short term, but becomes detrimental in the long term. Third, the BRVM and the Nigerian Stock Exchange are more responsive to changes in monetary policy than the Ghana Stock Exchange. Thus, as economic policy implications, an expansionary monetary policy could be considered to boost stock market performance in the long term in the ECOWAS region, while in the short term, a restrictive monetary policy could be more effective in improving stock market performance in the region. However, monetary authorities should exercise caution, as excessive expansion of the money supply could have negative consequences for both the economy and stock markets in the region.

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## The effect of inflation and fiscal decentralization on income inequality in Sumatra Island of Indonesia: a panel data

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**Abstract.** *The aim of this research is to analyze the relationship between the influence of the fiscal independence index, regional spending and inflation on income inequality in ten provinces on the island of Sumatra. This research uses panel data regression, namely the Fixed Effect Model (FEM). The findings of this research indicate that regional spending has a significant negative relationship with income inequality. The role of regional spending has an impact on reducing income inequality. The fiscal independence index has a significant negative effect on reducing income inequality. Inflation has a positive and significant relationship to income inequality.*

**Keywords:** income inequality, local government expenditure, Fiscal Independence Index, inflation, Fixed Effect Model.

**JEL Classification:** E31, E43, E52.

## Introduction

Inequality in terms of income in society occurs because of the background of social life which causes differences in carrying out economic activities such as per capita expenditure and income receipts. The high level of inequality in per capita income affects the economy of a region. This inequality often occurs due to differences in characteristics observed in farming and non agricultural households such as educational background, internal transmission and household composition, ethnicity and income. Households with a non-agricultural income base have more productive influence factors resulting in higher per capita consumption expenditure. (Pham et al., 2023). Reducing income inequality is an important goal of sustainable development for the welfare of the population because income inequality has a detrimental impact on the regional economy (Batuo, Kararach and Malki, 2022). A comprehensive assessment of income inequality requires integration between them (Kim, Park and Ju, 2024).

Figure 1 shows the region of Sumatra Island in Indonesia which consists of the provinces of Nangroe Aceh Darussalam, North Sumatra, Riau, West Sumatra, Jambi, Bengkulu, South Sumatra, Lampung, Riau Islands and Bangka Belitung Islands which have similar agglomerations limited by the same characteristics of economic and social life, faced with challenging problems in terms of income inequality in society in ten provinces. In the ten years period 2010-2023, conditions of unequal distribution of income exist in the population distribution in the Sumatra region with an average Gini index of 0.331, this suggests that the distribution of income inequality that occurs in Sumatra still exists and needs to be addressed by the regional government.

**Figure 1.** Province on the Island of Sumatra in Indonesia



**Source:** Indonesian Map, processed data, (2024).

One of the factors that influences the income gap is the implementation of the financing system in regional government units. The most important thing to consider is the impact on social life of equality in the context of regional financial policies that affect inequality which is the impact of implementing public sector income sharing both vertically and horizontally between population income levels and public authorities. (Gałeczka et al., 2022). By providing wider regional fiscal capacity space so that the goal of regional fiscal



independence is further increased. The implementation of policies on fiscal decentralization in the regions provides appropriate flexibility for regional government authority in the fiscal sector (Petrovito et al., 2023).

Fiscal decentralization in the era of authority in terms of regional revenue management and expenditure arrangements within the scope of regional autonomy continues to be improved and innovated in seeking regional potential sources in the ten regional provinces of Sumatra. Fiscal consolidation has a positive impact on income inequality. This shows that if the difference between local government expenditure and income increases, it could lead to an increase in income inequality (Sarwar et al., 2023). The independence of regional autonomy policies that regulate, manage and manage regional financial capacity is reflected in the management of potential sources of regional tax revenue. Direct tax revenues can reduce income inequality, measured using the Gini index and indirect taxes can increase income inequality. Likewise, spending in the public development sector can reduce income inequality through job creation (S. Khan et al., 2022).

As a mandate from the central government for regional governments to have a stronger foundation for fiscal decentralization, the central government, through financial balance, has begun to reduce the value of transfers to regions, to assess the performance of regional development capabilities in financing public sector development. Increasing consumption of government spending can reduce inequality, which indicates that transfer spending has been successfully implemented in reducing income inequality (Destek, Sinha and Sarkodie, 2020). Decentralization in the form of direct regional government spending can affect income inequality. Widespread decentralization of autonomy, but the negative impact after the threshold is greater than the negative value before the threshold (Hung and Thanh, 2022). Consumption of government expenditure has the potential to reduce income inequality, but the effectiveness of its use is very dependent on the efficiency of government expenditure (Sergi, Balashova and Ratner, 2023). Regional government expenditure can reduce income inequality (Destek, Sinha and Sarkodie, 2020). Comparative analysis shows that financial development, human resource conditions, total productivity, inflation and urbanization are factors that influence each other on income inequality in a market economy (Wang, Gao and Luo, 2023).

Meanwhile, in terms of monetary policy, which has the effect of controlling inflation to reduce the negative impact of unequal inequality, it has a significant influence and regionally specific inflation can mitigate the impact of unanticipated monetary contractions which can cause income inequality (Tavares Garcia and Cross, 2024). Inflation control policies have contributed positively to reducing income inequality within households as measured by the Gini coefficient and minus the share of gross domestic product used for labor compensation (Altunbaş and Thornton, 2022). Inflation inequality that considers the distributional consequences of changes in product prices is important in several areas of dynamic policy making, starting from trade policy, monetary policy and tax redistribution (Jaravel, 2025).

Income inequality by evaluating the role of monetary policy in mitigating reducing income inequality is very important for local governments (Khan and Khan, 2023). Inflation control policies will have a positive impact which will result in a more equal distribution

of income in developing countries (Glawe and Wagner, 2024). Monetary policy in controlling inflation can influence income inequality by influencing the income of high-income households in financial markets and business operations (Xiang et al., 2023).

### Literature review

The view of several experts is that income inequality has a negative impact on economic growth. Economic policies and the influence of negative social impacts can be implemented to achieve the goal of reducing income inequality among middle-income people (Kanbur, Ortiz-Juarez and Sumner, 2024). The Lorenz curve provides an overview of the real quantitative-based relationship between the percentage value of income recipients and the percentage of total net income received during a certain time period, for example one quarter. The Lorenz curve is within the boundaries of a square with the vertical side explaining the cumulative percentage of national income, while the horizontal side explains the cumulative percentage of population. If the Lorenz curve approaches a straight line, it means that the distribution of national income is getting better. Policies in the economic sector can be achieved by economic growth and reducing population income inequality in the regional development transition (Nandan and Mallick, 2022). Income inequality is measured using the Gini Index indicator to see the causality between the amount of net income received by the population and total income receipts.

Fiscal decentralization in terms of local government expenditure arrangements aims to increase efficiency in reducing income inequality in countries with high income levels (Eifeky, El Nemr and Mousa, 2023). In the Keynesian general equilibrium model, macroeconomic policy is a way for the government to provide stimulus to aggregate demand by controlling regional tax revenues and intervening in regional spending. When regional expenditure consumption is increased and/or regional tax rates are reduced, there will be a multiplier effect from the government to the private sector in the form of investment which will impact demand for goods and services and capital will increase, if this is not followed by supply balance it will cause inflation occurs.

Decentralization of regional tax revenues will create a role between income redistribution and efficiency, with tax decentralization policies increasing regional fiscal space, but can also widen inter-regional inequality by triggering tax competition on mobile tax bases (Bellofatto and Besfamille, 2021). Meanwhile, the dynamic effects captured by increasing income inequality are still occurring in developed and developing countries. Empirical evidence shows that progressive income taxes respond more to reducing income inequality in developing countries and not in developed countries (Malla and Pathranarakul, 2022). Regional fiscal independence, by reducing dependence on transfers from the central government aims for better regional financial governance in terms of decision-making authority to regional governments, which can contribute to reducing income inequality by improving community welfare (Kim, Kim and Park, 2020).

The Keynesian view of uncontrolled inflation shocks because the population lives outside of its economic control and capabilities with a priority on how economic activity between population groups can have an impact on demand that is higher than the amount of goods

and services provided. Contractionary monetary policy shocks increase income inequality with the implementation of inflation control reducing the magnitude of the impact of income inequality. This indicates that region-specific inflation by controlling inflation can mitigate the impact of unanticipated monetary contractions which can cause income inequality (Tavares Garcia and Cross, 2024). According to Friedman (1976) shocks caused by inflation continuously and occurring anywhere are a monetary phenomenon Friedman (1976) refined the quantity expenditure theory by developing a theory of money demand. Inflation can occur due to a demand pull caused by an increase in prices as a result of a shift in aggregate demand upwards, while inflation due to a cost push is caused by an increase in prices which influences an increase in supply and reduces aggregate demand.

### Data and method

The focus of this research is on the influence analysis tools and main indicators of time series and cross sections for 2010-2023 in the ten provinces of Sumatra. The variables studied are the relationship between the Gini Index (GINI), local government expenditure (lnGE), Regional Fiscal Independence Index (IKF) and inflation (INF).

The method for estimating the panel data multiple regression model used in this research is the Common Effect Model (CEM) to estimate that the intercept and slope figures for the variables studied are the same for all cross section units and time series. Modeling does not have individual influence (common effect) is a grouped estimator based on time series data with an ordinary least squares (OLS) approach.

Fixed Effect Model (FEM) to estimate models using a dummy variable or fixed effect estimator approach and is also called a covariance model. The fixed effect model estimation method can be adjusted using no weight or least square dummy variable (LSDV) and by providing cross section weight or general least square (GLS) which aims to reduce the influence of heterogeneity between cross section units.

Random Effect Model (REM) to estimate a fixed effect model by including dummy variables and including the consequences of weakening degrees of freedom which in the end can reduce the efficiency of parameter values. To overcome this effect, a confounding variable (error term) which is called a random effect, can be used. This method is for estimating panel data that has confounding variables that are correlated over time and between variables.

$$GINI = f \{GE, IKF, INF\} \tag{1}$$

From equation (1) a regression equation can be formed for this research model, which is as follows

$$GINI_{it} = \alpha_{0it} + \alpha_1 \ln GE_{it} + \alpha_2 IKF_{it} + \alpha_3 INF_{it} + e_{it} \tag{2}$$

Description: GINI is Gini Index (annual percentage); GE is a Local Government Expenditure (logaritma natural); IKF is Fiscal Independence Index (Decentralization Fiscal); INF is Inflation;  $\alpha_0$  is a Constant;  $\alpha_1 - \alpha_4$  is a parameter;  $i$  is the number of observations (cross-section);  $t$  is a time series;  $e$  is Error Term.

**Table 1.** Variable Operational Definition

Variable	Definition	Measurement	Source
Gini Index	The level of population income inequality is based on the cumulative proportion of expenditure and the cumulative proportion of the population	Cumulative proportion of population, cumulative proportion of expenditure (Index)	Indonesian Central Statistics Agency
Local Government Expenditure	Consumption of local government expenditure in the form of regional expenditure	Total local government expenditure (IDR)	DJPK, Ministry of Finance Republic Indonesia
Fiscal Independence Index	Regional independence in financing development sourced from Original Regional Income	Total Regional Original Income divided by total regional income (Index)	DJPK, Ministry of Finance Republic Indonesia
Inflation	Inflation in this study uses the Consumer Price Index (CPI) measure. The CPI measures the extent to which the prices of various goods and services consumed by the average household rise or fall over a period of time.	Consumer Price Index Total, Annual growth rate (%)	Indonesian Central Statistics Agency

Source: Author Compilation, (2024).

## Result and discussion

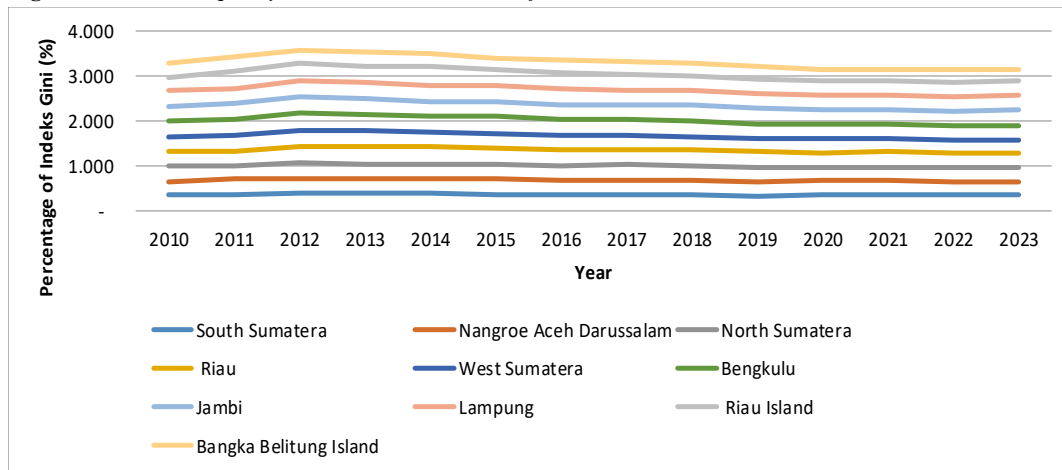
### Variable Movements of Income Inequality on Provinces the Island of Sumatra

The existence of unequal distribution between population groups with high incomes and those with low incomes can cause income inequality within community groups. According to view (Adeleye et al., 2020) that the growth of income inequality will worsen poverty conditions and the interaction of poor economic performance and income inequality will worsen poverty rates. In aggregate, the average distribution of high inequality occurs in residents who live in urban areas compared to rural areas, this is because certain occupational groups are dominated by rich people with high educational backgrounds and competency abilities.

Meanwhile, the opportunity to pursue a higher level of education is still very limited for low-income population groups, so that employment opportunities at high wages are also limited. The performance of population income distribution has a significant mediating effect on the relationship between economic growth and poverty rates (Mageto Nyamweya and Ochieng Obuya, 2020). According to view (Brychka, Vyslobodska and Voitovych, 2023) states that the most significant factors for reducing poverty are loan interest rates, Gini index in income distribution, GDP per capita, income tax, unemployment rate and company profits.

The trend of income inequality in the ten provinces on the island of Sumatra is very fluctuating, not showing a trend that is sloping down or increasing significantly, however the regional government must see that the condition of income inequality continues to be reduced through several productive regional spending programs and relaxation in determining regional taxes. Stages for risk mitigation so that this condition of inequality does not widen, starting from opening access to education and health services for early childhood, preparing vocational education so that job opportunities are wide open, opening wide access to labor-intensive job vacancies for low-income residents and interventions through the determination of fair regional minimum wages.

**Figure 2.** Income Inequality on Provinces the Island of Sumatra



Source: Indonesian Central Statistics Agency, processed data, (2024).

Figure 2 shows the performance of the Gini ratio in the research object area. In aggregate, the average inequality ratio is still quite high, between 0.279 - 0.354. The province with the highest average over fourteen years is South Sumatera Province with a value of 0.354, Riau Islands Province with a value of 0.353 and Bengkulu Province with a value of 0.348. The lowest inequality in a row is as follows: Bangka Belitung Islands Province with a value of 0.279, West Sumatera Province with a value of 0.316 and North Sumatera Province with a value of 0.320.

### Variable Movements of Government Expenditure on Provinces the Island of Sumatra

The role of regional governments in efforts to reduce income inequality in each region is reflected in the productivity of government consumption in the form of local government expenditure with a focus on programs to reduce income inequality. Local government governance in expenditure that is not yet good does not respond to reducing the index of misery or poverty (George-Anokwuru, 2023). Local governments can rely on local government expenditure priorities to achieve poverty alleviation programs to reduce disparities (Min and Rao, 2023). Local government expenditure in the areas of forestry, water resources and agriculture as well as urban and rural affairs, effectively narrows income gaps (Yan, Tu and Zheng, 2023).

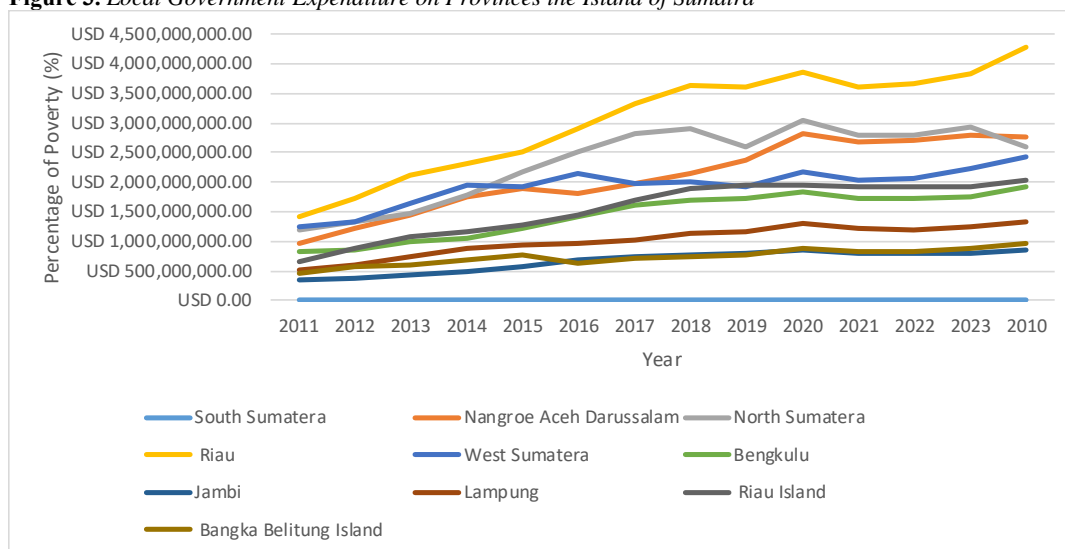
Through the Regional Revenue and Expenditure Budget, with a composition of operating expenditure and development capital expenditure. Operational expenditures with scope include personnel expenditures as well as goods and services expenditures, to finance improvements in employee welfare with the hope of reducing the distribution of income inequality. Fiscal decentralization has an influence on the results of the human development index and poverty reduction depends on the nature and scope of fiscal decentralization, regional characteristics and capabilities and the design of fiscal decentralization (Mutembe, 2022). Interestingly, the research results show that improving the quality of

governance in Africa can contribute to spurring positive urbanization which can contribute to improving urban economies and reducing income inequality (Dossou, 2023).

Consumption of government spending in socially valuable operating expenditures is associated with reduced income inequality, while unemployment and population size appear to widen income inequality (De Wettinck and van Mourik, 2024). Development capital expenditure is directed at creating a double multiplier effect for economic activity, including spending on the basic infrastructure sector as a pioneer of inter-regional connectivity so as to facilitate the flow of distribution of goods and services and reduce transportation logistics costs to make them cheaper. Consumption of development capital expenditure has a positive and statistically significant impact on income inequality (Chinedu, 2021; Obayori, J.B., 2020). Fiscal decentralization in terms of local government expenditure, especially in regional education and welfare sector spending as well as economic growth, has an impact on reducing regional income gaps (Pham et al., 2022). In Figure 3 below, the development of total local government expenditure in each region is presented.

Figure 3 shows the development of total regional expenditure on the research object. The period 2010–2023 shows that consumption of local government expenditure is increasing. The dynamics of development needs along with demand require increasingly large regional budgets.

**Figure 3.** Local Government Expenditure on Provinces the Island of Sumatra



**Source:** Indonesian Central Statistics Agency, processed data, (2024).

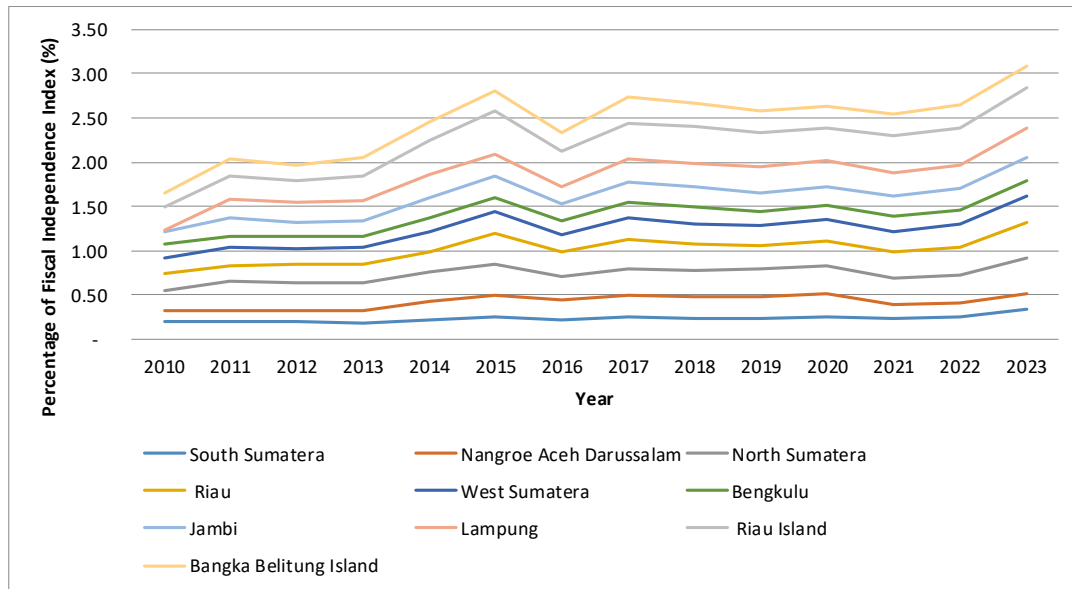
Fiscal decentralization with increasingly large spending capacity requires regional governments to be creative in finding sources of development financing, not just relying on APBD conditions. Fiscal decentralization aimed at redistributing mobilized income leads to a strengthening of fiscal space, while redistribution of profits results in a reduction in income inequality (Bilbiie, Känzig and Surico, 2022).

### **Variable Movements of Fiscal Independence Index on Provinces the Island of Sumatra**

The implementation of regional autonomy opens up opportunities for regional governments in fiscal decentralization authority. The authority that has been given is in the form of more focused spending arrangements and looking for legitimate regional revenue sources. Regional revenues which are managed in accordance with the authority delegated from the central government are in the form of Regional Original Income which consists of components of regional taxes and levies, other legitimate regional original income as well as the results of separated regional assets. Governments in developing countries can increase revenue collection by strengthening the tax base, local borrowing and collecting taxes from fees. However, this is even more of a challenge for developing countries (e.g., Thailand and Indonesia) with larger informal sector revenues (Durongkaveroj, 2022).

Fiscal decentralization is expected to provide the ability to strengthen the regional tax sector with a strong tax base. Taxes administered by local governments on private companies in the regions can reduce regional income inequality permanently at no cost to aggregate growth, as can the implementation of uniformity in central transfer regulations (Yang et al., 2024). Fiscal decentralization independence with the Fiscal Independence Index (IKF) indicator is the ratio of PAD to total regional income receipts, where the higher the resulting ratio, the more independent a region is. If regions are independent in terms of regional revenues, this can have an impact on freedom in setting more focused thematic spending, such as spending on poverty alleviation themes. Fiscal decentralization and redistribution of intra-regional income inequality, with emphasis on the different roles of decentralization from the expenditure side and negative redistribution of income inequality from the income side (Petrovito et al., 2023). Fiscal decentralization in terms of revenue receipts has an impact on income inequality reduction and has an impact on poverty alleviation (Pham et al., 2022). With limited state financial capacity and increasingly complex State Revenue and Expenditure Budget burdens, evaluation of central government transfer funds continues to be reduced. That decentralization on the revenue side has a negative and significant relationship to income inequality rates (Digdowiseiso, 2022). The following shows Figure 4 of the development of fiscal independence in the research object as follows.

Figure 4 shows the development of the fiscal independence index for the research object, where there are two provinces, namely Nangroe Aceh Darussalam Province and Bengkulu Province, which are in the not yet independent group with an IKF value of less than 0.25 and eight other provinces are in the towards independence group with a value of  $0.25 < \text{IKF} < 0.50$ . For the ten provinces on the island of Sumatra, not a single region is included in the regional category with fiscal independence of  $0.5 < \text{IKF} < 0.75$  or very independent  $\text{IKF} > 0.75$ .

**Figure 4.** Fiscal Independence Index on Provinces the Island of Sumatra

Source: Indonesian Central Statistics Agency, processed data, (2024).

### Variable Movement of Inflation on Provinces the Island of Sumatra

Inflation is often associated with the social life of the poor and has a negative impact on the distribution of per capita income. A consumer price index characterized by higher food prices can be detrimental to the welfare of poor people with low incomes, especially in some urban areas, but can provide benefits to producers and reduce poverty rates in rural areas. Based on food and non-food price data available at the level of each provincial region, it provides information that distinguishes the influence of food and non-food inflation on changes in income inequality.

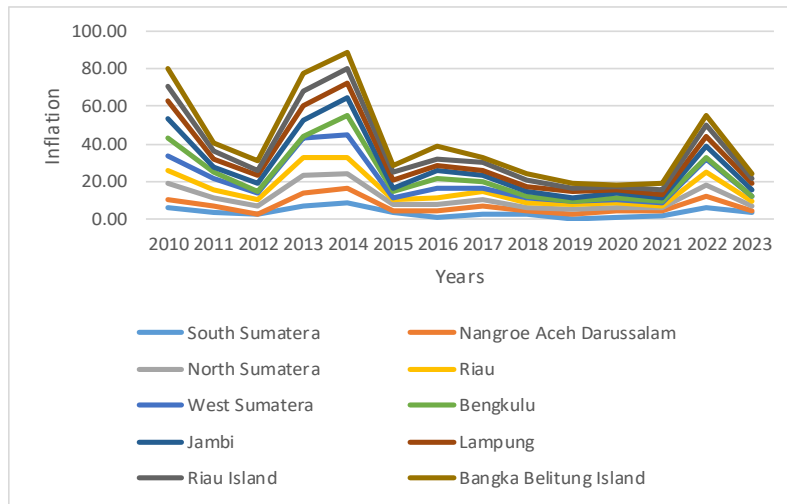
If wage levels in rural areas are relatively elastic to food prices, higher food inflation will improve or at least not have a negative impact on income inequality in rural areas, but the impact in urban areas, like non-food inflation, will most likely be negative. With the consumer price index, we can assess the impact of food and non-food inflation separately on income inequality in rural and urban areas. Non-food inflation will result in poor performance for income inequality in both regions, but food inflation in urban areas is also estimated to further worsen the situation of income inequality.

However, if wage levels in rural areas respond elastically to increases in food prices, then higher food inflation should have a positive impact on reducing income inequality in rural areas. Regional governments implement various strategies and policies, including social safety net and redistribution policies as well as encouraging regional economic inclusion, with the collaboration of monetary policy and fiscal decentralization maintaining market balance, implementing progressive taxation, and changes in labor market demand (Ali &



Asfaw, 2023). Figure 5 presents data on the development of inflation control in ten provinces on the island of Sumatra as follows.

**Figure 5.** Inflation on Provinces the Island of Sumatra



**Source:** Indonesian Central Statistics Agency, processed data, (2024).

Figure 5 shows inflation data in ten provinces on the island of Sumatra over a period of fourteen years 2010-2023. The highest average inflation was in the Bangka Belitung Islands Province at 5 percent, then West Sumatera Province at 4.68 percent and Lampung Province at 4.54 percent. The lowest average inflation value was in Bengkulu Province at 2.79 percent, South Sumatera Province at 3.52 percent and Aceh Province at 3.53 percent.

**Model Estimation Results**

**Chow Test Results**

The chow test is used to estimate panel data models between common effects and fixed effects, the use of the chow test is to measure the stability performance of model parameters, this test hypothesis:

p-value is smaller than the 5% confidence level, then H0 is rejected and H1 is accepted  
 p-value is greater than the 5% confidence level, then H1 is rejected and H0 is accepted

**Table 2.** Chow Test Results

Effect Test	Statistik	d.f	p value
Cross-section F	21.520474	(9,127)	0.0000
Cross-section Chi <sup>^</sup>	129.677793	9	0.0000

**Source:** Author’s calculation based on output E-Views 13 (2024).

Table 2 shows that the results of the Chow test, for F and Ch<sup>^</sup> values respectively 0.0000, where the p-value is smaller than the confidence level of 0.05, then the hypothesis H0 is rejected and H1 is accepted, then the fixed effect model and conditions are chosen. is met to continue with the Hausman test.

### Hausman Test Results

The Hausman test is a test to analyze the best model approach and is appropriate to regressed panel data, an approach carried out by comparing fixed effects and random effects. The Hausman test uses the  $\chi^2$  value, so that the conclusion on selecting the panel data method in this research can be determined statistically with the hypothesis:

H0: The model used is random effect

H1: The model used is fixed effect

p-value is smaller than the 5% confidence level, then H0 is rejected and H1 is accepted

p-value is greater than the 5% confidence level, then H1 is rejected and H0 is accepted

**Table 3.** Hausman Test Results

Test Summary	Chi <sup>2</sup> Statistik	Chi <sup>2</sup> d.f	p value
Cross-section random	11.190301	3	0.0107

**Source:** Author's calculation based on output E-Views 13 (2024).

Table 4 explains that the Hausman test results show a p-value of 0.0048 which is smaller than the confidence level of 0.05, so H0 is rejected and H1 is accepted so that the fixed effect model is better when compared to the random effect model.

**Table 4.** Model Estimation Results

Dependent Variable : GINI				
Variable	Coefficient	S.E	t-Statistic	p-value
C	0.709030	0.135824	5.220214	0.0000***
lnGE	-0.012227	0.004482	-2.727712	0.0073***
IKF	-0.044151	0.020196	-2.186124	0.0306**
INF	0.001519	0.000343	4.432945	0.0000***
R-squared			0.959136	
Adjusted R-squared			0.955275	
F-statistic			248.4039	
p-value (F-statistic)			0.000000	
Fixed Effects (cross)				
_Sumatera Selatan_C	0.029499			
_Aceh_C	-0.002701			
_Sumatera Utara_C	0.002340			
_Riau_C	0.019137			
_Sumatera Barat_C	-0.015197			
_Bengkulu_C	0.007144			
_Jambi_C	-0.002029			
_Lampung_C	0.005758			
_Kepulauan Riau_C	0.021258			
_Kepulauan Bangka Belitung_C	-0.065209			

**Note:** \*\*\*, \*\* and \* represent statistical significance at 1%, 5% and 10%

**Source:** Author's calculation based on output E-Views 13, data processed, (2024)

The results of the model estimation test using the Fixed Effect Model are as follows:

$$GINI_{it} = 0.709030_{it} - 0.012227lnGE_{it} - 0.044151IKF_{it} + 0.001519INF_{it} + e_{it} \quad (3)$$

In equation (3) above, the constant value of 0.709030 explains that if regional expenditure (lnGE), Fiscal Independence Index (IKF) and inflation (INF) are zero or no performance, then income inequality (GINI) will increase by 0.709 percent. The lnGE variable coefficient of -0.012227 explains that if the value of the regional expenditure variable (lnGE) increases by one percent, with other variables considered constant, then the value of the GINI variable will decrease by 0.012 percent. The lnGE variable has a p-value of less than 0.01 which explains that at a confidence level of one percent it has a significant influence on GINI.

The IKF variable has a coefficient of -0.044151, explaining that if the value of the IKF variable increases by one percent and other variables are considered constant, then the value of the GINI variable will decrease by 0.044 percent. The IKF variable has a p-value of less than 0.05 which explains that at a confidence level of five percent it has a significant influence on the GINI variable. The INF variable has a coefficient of 0.001519, explaining that if the value of the INF variable increases by one percent and other variables are considered constant, then the value of the GINI variable will increase by 0.0015 percent. The INF variable has a p-value of less than 0.01, explaining that at a confidence level of one percent it has a significant influence on the GINI variable.

In equation (3) above, the coefficient of determination value obtained is an R-Squared value of 0.959136, which means that the influence of the variables studied lnGE, IKF and INF together influence income inequality in 10 provinces on the island of Sumatra by 95.91 percent. while the remaining 4.09 percent is influenced by other variables outside this research model. The F-statistic value in this model equation is 248.4039 with a significance value of 0.000000 or smaller than the confidence level of 0.01 so it can be interpreted that  $H_0$  is rejected and  $H_a$  is accepted, regional spending, the fiscal independence index and inflation simultaneously have a significant effect on income inequality in ten selected provinces on the island of Sumatra.

## Discussion

### **The Effect of Government Expenditure on Income Inequality on Provinces the Island of Sumatra**

The estimation results from the selected model from this research indicate that local government consumption in the form of regional spending has a negative relationship with reducing income inequality in ten provinces on the island of Sumatra. The results of this research confirm that they are in line with research conducted by (Jena and Barua, 2020). Local government expenditure is productive and focuses on reducing income inequality, either directly or as a derivative of the impact of development in other sectors, which provides a double multiplier effect. The results of this research indicate that they are in line with research conducted by (Yan and Mohd, 2023).

Operational expenditure takes the form of employee expenditure in the form of salaries and allowances to improve employee welfare as well as expenditure on goods and services to support the small and medium enterprise sector group. By improving employee welfare,

you can increase consumption and increase individual business capital, thereby creating business opportunities that can absorb the workforce. Local government expenditure which focuses on forestry and water resources as well as agriculture in urban areas and rural affairs, effectively narrows income inequality, this result is in line with research conducted by (Yan, Tu and Zheng, 2023). Local government expenditure on a social security safety net for the population can reduce income inequality in rural areas. These results confirm in line with research conducted by (YU and LI, 2021).

Through spending on goods and services that can stimulate the growth of the Micro, Small and Medium Enterprises sector so that it can expand MSME business opportunities and absorb local workers. Efforts to overcome income inequality require an aspirational approach by combining innovative initiatives from the role of the private sector and government policy reform. The potential role of local government policies could help reduce income inequality and increase provincial regional minimum wages. This result is in line with opinion (Wang et al., 2024). With local wisdom in each region, MSMEs can be encouraged to provide food services and clothing convections that are characterized by regional local content. So, by extensifying the MSME business sector, it can increase demand for labor and reduce unemployment in the regions, this has a positive impact on reducing income inequality in the regions. The results of this research are in line with research conducted by (Ali & Asfaw, 2023).

Through the role of capital expenditure, infrastructure development can create a positive multiplier effect for inclusive economic growth, thereby reducing the negative impact of income inequality. The results of this research are in line with research by (Destek, Sinha and Sarkodie, 2020). Sustainable infrastructure development, creating good basic services thereby reducing disparities between regions, so that equitable development can be achieved. Local government expenditure on road infrastructure development strengthens the smooth flow of distribution of goods and services and can reduce logistics transportation costs so as not to cause high price disparities between regions. The impact of local government expenditure consumption in the form of regional spending on decreasing income distribution is in two ways, first, it will affect the number of low and middle income groups and second, it will have an impact on reducing high income groups. These results are in line with this view (Lian, Pei and Li, 2024).

### **The Effect of Fiscal Independence Index on Income Inequality on Provinces the Island of Sumatra**

The estimation results from the model selected in this study show that the regional fiscal independence index has a negative and significant relationship to reducing income inequality in ten provincial regions on the island of Sumatra. The results of this research confirm that they are in line with research conducted by (Suhrah, Khan et al., 2022), but it is not in line with research (Hanny Tri Putri et al., 2022). The more independent a region is, the greater the regional government can allocate financing for regional development and the smaller the dependence on transfer funds from the central government.

Regional fiscal independence in terms of revenue means that the region is increasingly able to finance development by exploring potential sources of regional revenue. Through

Regional Original Income, revenues from the regional taxes and levies sector by strengthening the regional tax base, extensification and intensification as well as diversification of regional taxes can increase regional tax realization. This is in line with the view (Digdowiseiso, 2022) that decentralization on the revenue side has a negative and significant relationship to income inequality rates and is in line with research by (Pham et al., 2022).

Strengthening regional tax sector revenues and reducing dependence on central government transfer funds, so that regions can be more focused and flexible in managing program spending to reduce income inequality. These results confirm in line with the views (Petrovito et al., 2023). Meanwhile, transfer funds from the central government have limitations and focus on handling other sectors. Intergovernmental transfer funds have a weak level in reducing inequality when compared with fiscal decentralization in the form of local government expenditure. These results are in line with research conducted by (Mutembei, 2022). Apart from increasing regional revenues from the regional tax sector, regional governments also play a role in providing stimulus or encouragement to the business sector in expanding its business, including by relaxing or providing tax incentives through reducing regional tax rates. These results are in line with research (Yang et al., 2024).

Thus, increasing the role of Regional Original Income to strengthen regional fiscal independence in terms of revenue is very meaningful for increasing the regional fiscal independence index. Policy implications that can reduce income inequality in the long term, especially through improving the quality and skills of the workforce, as well as the good role of local governments by using redistributive income with instruments such as progressive income tax and cash assistance to low-income groups. These results are in line with this view (Goh et al., 2023).

### **The Effect of Inflation on Income Inequality on Provinces the Island of Sumatra**

The estimation results from the model selected in this study show that inflation has a positive and significant relationship to reducing income inequality in ten provincial regions on the island of Sumatra. The results of this research confirm that they are in line with research conducted by (Tavares Garcia and Cross, 2024). Shocks that occur as a result of uncontrolled inflation cause the price of goods in the product market to experience a significant increase which can affect consumption per capita expenditure very limited.

Inflation can influence the continuous increase in prices of goods and the effects of inflation from previous periods can still be felt during current conditions. Inflation control policies must remain controlled by the Central Bank authority, one of which is a structured monetary policy starting from controlling bank loan interest rates and controlling the money supply. These results are in line with research conducted by (Altunbaş and Thornton, 2022).

When there is an increase in inflation in an area, the aggregate demand for goods and services in the product market will decrease, causing income from production factors to decrease. To reduce fixed production costs for goods, some companies will reduce

employee spending incentives and this will even have an impact on reducing the number of employees, resulting in unemployment which will have a negative impact on income inequality. Reducing the number of employees with low educational backgrounds, so that the proportion of the population with low income or no income increases. These results are in line with research conducted by (Jaravel, 2025).

However, the disinflation policy implemented by the Central Bank will have a good impact, most likely resulting in a more equal distribution of income in countries with high inflation. There is no such effect in low inflation situations (Glawe and Wagner, 2024).

## Conclusion

The results of the estimation of the selected model in research from panel data show that regional spending shows a negative and significant relationship to income inequality. In line with this, regional government efforts to reduce income inequality have focused on operational spending which directly touches on improving employee welfare through employee allowances and incentives which have helped small and medium businesses. Meanwhile, spending on goods and services also provides stimulus to micro, small and medium enterprises, helping business capital. Capital expenditure for infrastructure development which continues to be increased has a multi-flyer effect on the regional economy, thereby providing an incentive for every factor of production to generate income.

The regional fiscal independence index in terms of regional income shows a negative and significant relationship with efforts to reduce income inequality. Creative efforts to find potential sources of regional income continue to be increased by strengthening the regional tax revenue base through tax extensification, intensification and diversification. Then encourage the participation of Regional Owned Enterprises to be more independent and create increased income from regional levies and provide opportunities for the private sector through collaboration between government and business entities. Partnership patterns are an important factor in reducing income inequality and changing selection to partnerships can answer the challenge of changing income inequality for the better (Erola and Kilpi-Jakonen, 2022). Reducing dependence on regional revenues from central government financial balancing funds so that regions are more independent in their ability to finance regional development.

Inflation shows a positive and significant relationship to reducing income inequality, this proves that the collaboration of monetary policy in controlling inflation with fiscal decentralization policy in terms of regional income and expenditure has gone hand in hand in creating balance in the product market and money market. The inflation rate can be controlled in line with the Central Bank's policy to control the amount of money in circulation and control bank loan interest rates.

Regional policy makers need to consider that income inequality in society is a key indicator of regional economic success and look at regional spending, regional fiscal independence and controlling inflation as preventive measures so that income inequality does not widen further.

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## **Exploring the relationship between the Put Call Ratio and Market Indices: a comparative analysis of S&P 500 and BET**

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**Abstract.** *The equity put/call ratio (PCR) from the Chicago Board Options Exchange (CBOE) is widely regarded by market participants as an indicator of market sentiment and positioning. While frequently used as a contrarian signal for traders, long-term investors often adjust their positions based on extreme PCR levels. This paper evaluates the relevance of the PCR as a sentiment indicator by examining its correlations, causal relationships, and responsiveness with the S&P 500 and BET indices. By conducting an empirical analysis across two distinct markets developed market and a frontier market, the study sheds light on the behavior of the PCR in these contrasting contexts, with particular emphasis on the structural limitations and behavioral nuances of the BET index. The findings reveal that while the PCR demonstrates limited predictive capacity for market movements, shocks to the S&P 500 significantly influence the PCR. Conversely, the relationship between the PCR and the BET index is negligible, reflecting the unique constraints of the Romanian market, such as its low liquidity and the absence of derivative markets. These results underscore the need to adapt sentiment indicators to the specific characteristics of frontier markets.*

**Keywords:** #putcallratio; #betindex; #sp500; #sentimentindicator.

**JEL Classification:** G11, C32, C58.

## 1. Introduction

This study aims to explore the relationship between the put-call ratio (PCR) and two major market indices: the S&P 500, representing one of the most influential global markets, and the Bucharest Exchange Trading Index (BET), providing insights from a European frontier market. The Romanian stock market, represented by the Bucharest Exchange Trading Index (BET), is characterized by several unique features that set it apart from developed markets. These include low trading volumes, a limited number of listed companies, and the dominance of a few key industries, such as energy and financial services. Additionally, the absence of a well-developed derivatives market limits the availability of advanced financial instruments like futures and options. These structural constraints significantly influence market dynamics and the applicability of sentiment indicators like the Put-Call Ratio (PCR). Understanding these characteristics is crucial for interpreting the results of this study and evaluating the relevance of sentiment indicators in frontier markets like Romania. Beyond direct forecasting, the Put-Call Ratio (PCR) offers numerous applications in financial decision-making. In risk management, the PCR can signal shifts in market sentiment, allowing portfolio managers to adjust their hedging strategies or conduct stress tests under extreme market scenarios. Additionally, PCR can inform portfolio optimization by serving as a sentiment-based input for dynamic asset allocation and behavioral adjustments. Finally, as a tactical tool, the PCR can act as a contrarian indicator or aid in market timing, helping traders exploit overbought or oversold conditions. These alternative applications highlight the broader utility of PCR in modern financial markets. Understanding the correlation between market indices and the PCR offers valuable information about how derivatives trading reflects broader market performance. This analysis not only helps in predicting market trends but also contributes to a deeper understanding of economic indicators and their impact on financial markets. The unique context of the Romanian market, characterized by the absence of derivative instruments and a relatively illiquid stock market, presents an underexplored opportunity to examine the limitations of sentiment indicators like the PCR. Unlike developed markets, the structural constraints of frontier markets such as BET provide new insights into the PCR's relevance and predictive capabilities. In the intricate world of finance, identifying the dynamics between market indices and derivative indicators like the PCR is crucial for both investors and policymakers. Investors rely on a few critical figures to make informed decisions. Among these, PCR provides a measurable indicator of market sentiment, which is often dominated by two psychological forces: fear and greed. By studying such metrics, investors can identify opportunities for speculation or protection against potential losses caused by abrupt market changes. Options, which are financial contracts used by speculators and hedgers alike, play a key role in this analysis. These contracts grant the buyer the right, but not the obligation, to buy (call options) or sell (put options) an underlying asset at a set price before a specific expiration date. The PCR, which measures the ratio of traded put options to call options, serves as a gauge of market sentiment.

Traditionally, a high PCR suggests bearish market sentiment, while a low PCR indicates bullish conditions. This study draws on foundational works such as Fisher Black (1975), who find that writing covered options often leads to profits, and the analysis by Easley, O'Hara, and Srinivas (1998), which examined the informational value of option trading volumes (David Easley; Maureen O'Hara; P.S. Srinivas, 1998). However, the limited application of these theories to markets like BET, where options trading is absent, underscores the need for context-specific investigations. More recent studies show conflicting views on the PCR's predictive power. For example, Houlihan and Creamer (2019) found that changes in asset prices could be predicted by the volume of options trading, while Gang et al. (2020) argue that the PCR lacks a consistent correlation with index returns. These inconsistencies highlight the importance of examining the PCR's utility within distinct market environments, particularly in frontier markets where trading volume and sentiment dynamics differ significantly from developed markets. Contagion effects from developed markets like the U.S. to emerging markets in Europe, including Romania, have been explored in the literature, as seen in the works of Davidescu et al. (2023) and Nica et al. (2024) (Davidescu et al., 2023), (Nica et al., 2024). While these studies address broader market dynamics, they lack a focused analysis of how sentiment indicators such as the PCR interact with indices like BET. Our study aims to fill this gap by investigating the specific influence of PCR on Romania's frontier market. The findings of our analysis are in line with Vijh (1990) who examines the liquidity of the CBOE options market and contradicts popular belief when concluding that informational influences on the liquidity of options are not substantial (Vijh, 1990). In addition, they find that the volume of the options market does not significantly influence the spread of the options market, the same finding being also reported later by Cho and Engle (Cho & Engle, 1999). Furthermore, we critically evaluate prior findings that suggest the PCR is moderately effective in developed markets, like S&P 500 (Blau & Brough, 2015) but lacks consistent correlations with returns in emerging or frontier markets (Gang et al., 2020). This juxtaposition provides a foundation for understanding the limitations and potential adaptations of the PCR as a sentiment indicator.

The structure of this paper stands as follows: the introduction and literature review present the theoretical foundations and synthesize previous studies on PCR and market indices. The data section describes the dataset and descriptive statistics. The methodology outlines the models used in the empirical section, including the VAR model, correlation matrix, impulse-response function, and Granger causality tests. Finally, the results section discusses the empirical findings, followed by a conclusion that highlights the study's major insights, implications, and directions for future research. The Chicago Board Options Exchange (CBOE) provides key statistics for the options market, with the put/call ratio (PCR) being one of the most widely used and easy-to-interpret indicators. A high PCR typically signals a bearish market, indicating uncertainty, while a low PCR suggests optimism and a bullish environment. As a contrarian indicator, extreme PCR values are

often used by traders to anticipate market reversals—a high PCR may signal a market bottom, while a low PCR may indicate a market peak. Understanding the correlation between the PCR and stock indices is particularly useful for investors seeking to better navigate market sentiment.

## 2. Literature review

This study aims to fill a gap in the literature by examining the efficiency of the PCR in relation to both the S&P 500 and BET indices. Our findings indicate that while the PCR is not always a reliable predictor of major market movements, shocks to the S&P 500 can influence the PCR. In contrast, the impact on the BET index remains insignificant. Through a comparative analysis of these indices and the PCR, this research seeks to understand how market sentiment, as reflected in the PCR, correlates with market performance under varying economic conditions. Using statistical techniques to analyze historical data, this study will quantify the strength and nature of these correlations over time, contributing to the literature by providing new insights into market dynamics and their implications for decision-makers and investors.

The informational role of transaction volume in options markets and its predictive power for stock prices has been extensively studied as well. According to Easley, O'Hara, and Srinivas (1998), the causal relationship between stocks and derivatives exists only in an ideal market (David Easley; Maureen O'Hara; P.S. Srinivas, 1998). Additionally, research shows that short sales are more informative than regular sales transactions and understanding the constraints on short sales can provide valuable insights (Aitken et al., 1998). The simplicity of the PCR as a sentiment indicator is emphasized by Baker and Wurgler (2007), who link it to future cash flows and investment risk (Baker & Wurgler, 2007). Blau and Brough (2015) also find an inverse relationship between the PCR and future stock returns in the U.S. market, suggesting that PCR can be a useful proxy for short-sale constraints (Blau & Brough, 2015). The empirical relationship between the PCR and stock indices has been explored in various markets. For instance, Hu and Yang (2015) apply an asymmetric VARX-MGARCH model to analyze the correlation between the PCR and the SSE50 index. While no direct relationship between returns and the PCR was found, the model gives useful insights for the analysis of trading volatility (Gang, Jianhua, Nan Huang, Ke Song 2020). Similarly, Hameed and Jeon (2020) show that disagreement-based options trading volume has a negative impact on future stock returns, especially in the presence of stock misvaluation (Hameed & Jeon, 2020). Analyzing the S&P 500 index, Bandopadhyaya and Jones (2008) find that the PCR outperforms the VIX as a market sentiment indicator, using residuals from a random-walk regression (Bandopadhyaya & Jones, 2008). However, other studies, such as Son (2012), found little evidence to support a significant relationship between spot prices and PCR (Son, 2012). Fang et al. (2014) also

find minimal predictive power from technical and sentiment indicators, including the PCR, when considering broader economic cycles (Fang et al., 2014).

The study also incorporates insights from recent research into sentiment indicators during periods of economic instability. For instance, Amazouz (2022) analyzed market sentiment during the COVID-19 pandemic, finding that the PCR captured a significant portion of sentiment variation. These findings raise questions about whether PCR effectiveness is amplified during periods of heightened market volatility, a particularly relevant consideration for less stable markets like BET. Another study (Tsukahara and Tsuchimura, 2021) using a VAR model to assess the spillover effects of sentiment indices, such as the consumer confidence index and PCR, on the Nikkei Index, suggests that the PCR had a significant impact (Tsukahara & Tsuchimura, 2021). On the other hand, Zhou (2003) applies a VAR model to examine the equity put/call ratio and S&P 500 index over a five-year period, concluding that the PCR lacks predictive power and cannot effectively synchronize with market movements (Zhou 2003).

In a novel approach, Houlihan and Creamer (2017) explore the connection between social media sentiment and the PCR, finding that sentiment derived from Stocktwits could enhance the model's performance in predicting market movements (Houlihan & Creamer, 2017). Blau and Brough (2015) confirm a negative relationship between PCR and future returns, supporting the approach that options can act as substitutes for short selling, being unaffected by short-sale constraints (Blau & Brough, 2015). By situating the analysis within Romania's unique market context, characterized by low liquidity, concentrated industry dominance, and the absence of futures and options markets, this study contributes to the literature on adapting sentiment indicators to market-specific conditions.

The selection of the S&P 500 and BET indices is central to this study as they represent two contrasting market environments: a mature, developed market (S&P 500) and a frontier market (BET). The S&P 500 serves as a benchmark for global market performance due to its depth, liquidity, and role in reflecting macroeconomic trends. Conversely, the BET index provides insights into a less liquid and structurally constrained market, characterized by the dominance of a few industries and the absence of derivative trading mechanisms. This research is conducted with the future establishment of a derivatives market in Romania in mind, emphasizing the importance of understanding the limitations of sentiment indicators like the Put-Call Ratio (PCR). The findings highlight that the PCR lacks consistent relevance even in a mature market such as the United States, making it even less suitable as a key sentiment indicator in Romania. Investors should be cautious not to overemphasize the importance of such indicators in the Romanian context. To further contextualize this research, additional studies on emerging markets and their interconnections with other asset classes, such as the work by K. Chen (Chen 2024), will be referenced to highlight broader dynamics influencing market behavior.

### 3. Methodology

There is a strong belief among the participants in capital markets that the options market, and particularly the volume of trade, can be used as an indicator of market movement, having a high predictive power. We aim to test here this hypothesis by applying an autoregressive VAR model handling the causality relationship, in the Granger sense, between the PCR variables, S&P500 and the representative index of the Bucharest Stock Exchange (BSE), BET. These methods were selected to provide a nuanced understanding of bidirectional relationships, considering both short-term impacts and long-term dynamics between the indices and the PCR. This is especially important to identify the impact that the developed US stock market has on emerging and frontier markets, such as like the Romanian one. We remind you that at this point the Bucharest Stock Exchange Market received the status of an emerging market, therefore becoming a part of the FTSE Russell global indices, as of September 21, 2020. The choice of these methods was guided by the aim to understand the relevance and limitations of the PCR in an emerging market like Romania, where derivative markets are absent. The VAR model, Granger causality tests, and impulse-response functions allow us to evaluate these dynamics effectively.

To evaluate the predictive power of the Put-Call Ratio (PCR) for the S&P 500 and BET indices, we employed Granger causality tests and impulse-response functions (IRFs) derived from the vector autoregressive (VAR) model. These methods are well-suited for capturing short-term dynamics and bidirectional relationships between variables. The Granger causality tests assess whether past values of one variable contribute to predicting another, while IRFs provide insights into the magnitude and duration of shocks in one variable on another. Our results indicate that the PCR lacks consistent predictive capacity, particularly in the context of the Romanian market, emphasizing the limited utility of sentiment indicators like the PCR in such environments. These findings reinforce the need for caution when interpreting PCR as a reliable sentiment measure in either developed or frontier markets.

The vector autoregressive (VAR) model was selected due to its ability to capture bidirectional relationships and short-term dynamics in a straightforward and interpretable manner. This makes it particularly suitable for an exploratory analysis in a structurally simple and low-liquidity market like Romania. However, we acknowledge its limitations in capturing non-linear relationships, which are often observed in financial markets. These limitations will be addressed in the discussion section.

Our study uses data starting from July 6, 2016, until October 4, 2019. The data was obtained from different sources as follows: The data for S&P500 are from the Bloomberg database, the data for BET was obtained from the official BSE website, and the data for PCR was obtained from the Chicago Board of Trade official website. The timeframe of 2016-2019 was selected to focus on a relatively stable economic period, free from major disruptions such as the COVID-19 pandemic. This choice allowed us to examine standard market dynamics without the influence of extraordinary events, providing a clearer view of the



relationships between the PCR and market indices. While this approach offers valuable insights, the exclusion of more recent data represents a limitation that will be addressed in the conclusions. The data set contains the daily closes over more than 3 years between July 6, 2016, and October 4, 2019. The data has been processed to include common trading data, excluding weekends and legal holidays in both the US and Romania. The sample period was chosen to encompass various market conditions, providing a comprehensive view of potential correlations between the variables. This approach aligns with the context of the establishment of the Central Counterparty (CCP) and the introduction of futures and options markets in Romania. The aim is to understand correlations not only during periods of high volatility but also under regular market conditions, which are vital for the early stages of derivatives market development.

### 3.1. Stationarity

To check the stationarity of our series, we apply the augmented Dickey-Fuller test, which was created by Dickey-Fuller in 1979 (David A. Dickey and Wayne A. Fuller, 1979). The variable always has a unit root, indicating that it is non-stationary, according to the null hypothesis (H0). The alternative assumption (H1) implies that the unit root does not exist, leading to stationarity. Additionally, to reject the null hypothesis and establish the series as stationary, the p-value should be less than the significance level (0.05). We use ADF statistics (Augmented Dickey-Fuller statistic) which compares critical values to determine whether to reject the null hypothesis. The significant levels are 1%, 5% and 10%. We reject non-stationarity if the test statistic's value is less than or equal to the 5 percent critical value. The stationarity of the variables was tested using the augmented Dickey-Fuller (ADF) test. The results indicate that the PCR is stationary, while the S&P 500 and BET indices are non-stationary at their levels but become stationary when transformed into returns. This ensures that the variables are suitable for further analysis within the vector autoregressive (VAR) framework. We obtain the new variables in terms of returns for indices and deviation for PCR:  $SP_r$ ,  $BET_r$  and  $PCR_r$ . Put-Call ratio (PCR) is defined as the ratio of the trading volume of put options to call options:

$$PCR = \frac{\text{Volume of Put Options}}{\text{Volume of Call options}}$$

To standardize PCR, S&P 500 Index and BET Index, we calculate:

- The log-return of PCR as follows:

$$PCR_r = \ln \left( \frac{PCR_t}{PCR_{t-1}} \right),$$

where  $PCR_t$  is Put-call ratio at time  $t$  and  $PCR_{t-1}$  is Put-Call Ratio at time  $t-1$ .

- The log-return of the S&P500 Index is given by:

$$SP_r = \ln \left( \frac{SP_t}{SP_{t-1}} \right),$$

where  $SP_t$  is closing price of S&p500 at time  $t$  and  $SP_{t-1}$  is closing price of S&p500 at time  $t-1$

- The log-return of the BET Index is calculated similar:

$$BETr = \ln \left( \frac{BET_t}{BET_{t-1}} \right),$$

where  $BET_t$  is closing price of BET Index at time  $t$  and  $BET_{t-1}$  is closing price of BET Index at time  $t-1$ .

### 3.2. VAR Model

The vector autoregressive model (VAR) is known as a flexible model in the analysis of time series with several variables, being a continuation of the univariate autoregressive model. The model is mainly used in the description and estimation of the dynamics of time series, being popularized by Christopher A. Sims who suggested that the method with finite parameters used is only part of a dimensional space of infinite parameters (Sims, 1980). Thus, this approach treats all variables as endogenous and can only be applied under conditions of their stationarity.

Helmut Küchenhoff underlines the advantages of VAR models over vector error connection models by the fact that they can be used even if the cointegration structure is not known (Lederer & Küchenhoff, 2006). James H. Stock and Mark W. Watson bring to light the fact that, although dynamic macroeconomic stochastic general equilibrium models provide an intellectually coherent framework for policy analysis, they do not fit the data well (Watson, 2001). Zha, Tao, Waggoner, Daniel F., and Juan F. Rubio-Ramírez provide a general theory that can be used for both linear and non-linear restrictions, including impulse-response ones, to identify SVAR globally (Rubio-Ramírez, Juan F.; Waggoner, Daniel F.; Zha, 2008). The equations that make up a VAR model are functions of a set of variables, each of which represents a variable in the system as a function of both its own and the other variables' lagged values. An error term's constant covariance matrix, linearity, and stationarity are the three main presumptions of a VAR model. To further capture the dynamic interactions within the system, VAR models also assume that variables in the system have a contemporaneous effect on one another. Parameter estimation and model order selection are two essential steps in the estimation of VAR models.

The model order selection process establishes a suitable lag length for the VAR model. Three popular criteria for choosing the most appropriate model order are the Hannan-Quinn Information Criterion (HQIC), the Bayesian Information Criterion (BIC), and the Akaike Information Criterion (AIC). Parameters are estimated using methods such as maximum likelihood estimation (MLE), ordinary least squares (OLS), or Bayesian methods after the lag order has been established. When interpreting VAR models, the impulse response analysis becomes particularly important. It allows us to study how changes in one variable, such as shocks or innovations, affect the system over time. We can evaluate the system's dynamic interactions and transmission mechanisms by simulating the response of variables to a brief change in one while keeping the others constant. Identifying potential feedback loops and interdependencies, this analysis sheds light on both the short- and long-term effects.

### 3.3. Granger Causality test

To determine the direction of causality, we use the Granger causality test. Finding the variables that influence another variable in a determinative way is also helpful. The Granger causality allows us to assess the correlation between the present values of one variable and the historical values of other variables (Engel & Granger, 1987).

The Granger causality test's null hypothesis is that  $x$  is not caused by the lag values of  $y$ 's. The excluded variables cause the equation variable when the p-value is equal to or less than 0.05, indicating a causal relationship between the variables. However, when the p-value is greater than 0.05, the null hypothesis cannot be rejected at the 5 percent significance level, indicating that the excluded variables do not cause the equation variable and that there is no Granger cause. The Granger Causality Test is particularly suited to the study's objective, as it helps identify potential predictive relationships in the absence of a well-developed options market. For example, it allows us to evaluate whether the S&P 500 significantly influences the PCR or if the BET index reacts to changes in the PCR.

### 3.4. Impulse responses

Impulse-response analysis becomes particularly important in this context. It allows us to study how shocks to one variable, such as S&P 500 or BET, propagate through the system, capturing the system's resilience to shocks and interdependencies over time. This is essential for understanding dynamics in less developed markets like Romania.

The impulse response graphs are crucial for understanding the dynamic interactions and stability of the system modeled by the VAR, providing insights into how economic or financial variables react to changes over time within the context of your specific dataset. This analysis sheds light on the transmission of shocks within the Romanian market, where low liquidity and structural constraints can amplify or dampen responses, offering practical insights for investors and policymakers.

## 4. Results

### 4.1. Stationarity

In Table 1, we can see that both indices show growth, but BET shows higher volatility and stronger growth potential. The S&P Index shows a mean value of around 397. The skewness is near zero, indicating that the distribution is symmetric. The kurtosis is less than 3, suggesting a distribution that is light-tailed. The BET Index has symmetric distribution (skewness close to 0) and light tails (kurtosis less than 3), like the S&P Index. In the case of the PCR, there is a positive skew indicating a longer tail on the right side of the distribution. The kurtosis is close to 3, suggesting a near-normal distribution with slightly lighter tails. These characteristics underscore the distinct dynamics of the BET market, where higher volatility and structural constraints, such as low liquidity, influence its performance.

S&P Returns and BET Returns have both positive skewness and high kurtosis, indicating significant asymmetry and heavy tails in the distribution. For the variables SP, BET, PCR, the ADF test statistics (Table 2) are all above the critical values at 1%, 5%, and 10% significance levels, and the p-values are greater than 0.05, indicating that these variables are non-stationary at the levels. To make them stationary, we simply calculate simple returns for each variable, generating the following variables: SPr, BETr and PCRr. The ADF test statistics for these variables are well below the critical values at 1%, 5%, and 10% significance levels, and the p-values are 0.000, indicating that these variables are stationary at the levels.

The S&P 500 has experienced growth over the entire period of analysis, with some fluctuations (Figure 0-1). The overall upward trend indicates a positive market environment during this specific timeframe. The returns hover around zero without a discernible trend over time, indicating that daily performance varies without a consistent pattern of gains or losses. Similarly, the returns of the BET index (Fig.0-1 and Figure 0-2) fluctuate around zero, resembling the S&P 500, which suggests variability in performance. A significant spike could be an outlier, a data recording error, or a market reaction driven by an extraordinary event. The PCR index shows high volatility and no long-term trend. This pattern implies that it is influenced by market conditions that frequently change its valuation. The high variability in deviations, with values oscillating around zero, indicates that while there is substantial short-term fluctuation in the PCR index (Figure 0-3), there isn't a consistent deviation from the mean overtime. All three charts (Fig.0-1, 0-2 and 0-3) provide insights into the market dynamics and investor sentiment from 2016 to 2019. Both the S&P and BET indices show upward trends, indicating overall positive market performance during this period of reference. However, the returns on these indices are volatile, reflecting the inherent risks and market corrections during the period. The PCR provides an additional layer of insights into investor sentiment, showing that market participants were reacting strongly to various events during this period, leading to fluctuations in the ratio and corresponding returns. In Table 2., the ADF test results confirm that the PCR is stationary at its level, while the S&P 500 and BET indices required transformation into returns to achieve stationarity. This aligns with the expectations for time series data and ensures the robustness of the subsequent analyses

**Table 1.** Descriptive Statistics for S&P 500, BET Index, and Put-Call Ratio (PCR) Variables, Including Stationary Transformations (SPr, BETr, PCRr), for the Period 06.07.2016–04.10.2019

Variables	Obs	Mean	Std. Dev.	Min	Max	p1	p99	Skew.	Kurt.
SP	608	396.934	229.449	1	791	9	783	-.006	1.785
BET	608	399.082	229.449	1	797	10	789	.005	1.815
PCR	608	73.676	34.002	1	162	5	155	.348	2.687
SPr	608	2.022	22.67	-83.529	277.778	-40	72.222	7.306	84.062
BETr	608	.929	14.327	-83.333	200	-33.929	39.326	4.409	69.309
PCRr	608	34.226	178.821	-95.833	3000	-80.435	486.957	10.609	150.157

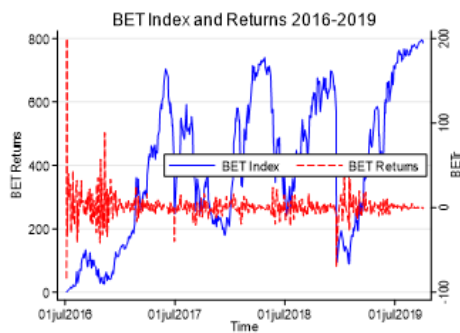
**Table 2.** Results of Augmented Dickey-Fuller (ADF) Test for Stationarity of S&P 500, BET Index, Put-Call Ratio (PCR), and Their Stationary Series (SPr, BETr, PCRr) for the Period 06.07.2016–04.10.2019

ADF test/Variable	SP	BET	PCR	SPr	BETr	PCRr
Test-statistic	-1.067	-1.043	-12.073	-22.110	-29.719	-19.855
p-value	0.7280	0.7374	0.000	0.000	0.000	0.000
Critical values						
1%	-3.445	-3.445	-3.445	-3.445	-3.445	-3.445
5%	-2.873	-2.873	-2.873	-2.873	-2.873	-2.873
10%	-2.570	0.3609	-2.570	-2.570	-2.570	-2.570

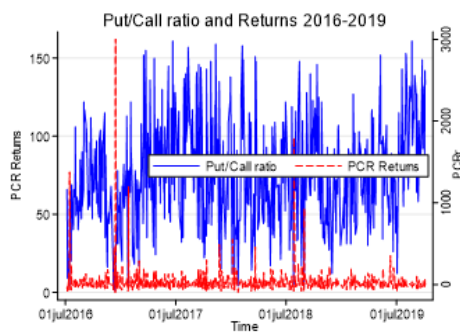
**Figure 0-1.** S&P 500 Index and Its Stationary Transformation (SPr) for the Period 2016–2019



**Figure 0-2.** Bucharest BET Index and Its Stationary Transformation (BETr) for the Period 2016–2019



**Figure 0-3.** Put-Call Ratio (PCR) and Its Stationary Transformation (PCRr) for the Period 2016–2019



#### 4.2. Lag-order selection

An essential component of econometric modeling, especially in the context of time series analysis, is the determination of lag length in autoregressive processes. The dependability of forecast outcomes, the robustness of inference, and the precision of model estimate are all strongly impacted by the lag duration; therefore, it must be determined correctly. In the literature, the significance of lag length optimal selection is emphasized by Lutkepohl (1993), who shows how an exaggerated lag order can raise mean-square forecast errors in Vector Autoregressive (VAR) models. On the other hand, autocorrelated errors frequently arise from underestimating the lag time, which can skew the coefficient estimates and jeopardize the reliability of statistical inference. These results emphasize how difficult it is to specify lag orders without causing either overfitting or underfitting. These theoretical insights are supported by the current analysis's findings as well. Given that significant lag effects are mostly seen in the first two periods, the selected lag length of two (2) specifically seems to be well-suited to capture the underlying dynamics among the variables under investigation. This decision strikes a compromise between simplicity and complexity, guaranteeing that the model accurately captures the relationships between the variables without adding extraneous parameters. This conclusion is supported, and the suitability of the two-lag specification is validated by the lag order selection criteria, which are shown in Table 3. Table 3 summarizes the values of these criteria for lags ranging from 0 to 2. As shown in the table, AIC: Lag 2 has the lowest value (29.9784), HQIC: Lag 2 also has the lowest value (30.0899), SBIC: Lag 2 has the lowest value (30.256), although it is closely comparable to lag 1, FPE: Lag 2 achieves the smallest value (2.1e+09). The model adheres to the principle of selecting the lag where the values of the information criteria are minimized. Based on these results, lag 2 was chosen as the optimal lag for the VAR model. The chosen lag time of two effectively represents the short-term dynamics among SP<sub>r</sub>, BET<sub>r</sub>, and PCR<sub>r</sub>, ensuring both model robustness and improved interpretation. These findings are consistent with the broad literature (e.g. Lutkepohl, 1993), and they reinforce the crucial role that lag order specification plays in econometric analysis.

**Table 3.** Lag-Order Selection Criteria for Vector Autoregressive (VAR) Model of S&P 500, BET Index, and Put-Call Ratio (SP<sub>r</sub>, BET<sub>r</sub>, PCR<sub>r</sub>.)

Sample: 08jul2016 thru 04oct2019  
Number of obs = 273

1)	Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
2)	0	-4137.08				3.0e+09	30.3302	30.3462	30.3699
3)	1	-4087.13	99.891	9	0.000	2.2e+09	30.0303	30.094	30.1889*
4)	2	-4071.05	32.165*	9	0.000	2.1e+09*	29.9784*	30.0899*	30.256

\* optimal lag

Endogenous: SP<sub>r</sub> BET<sub>r</sub> PCR<sub>r</sub>

Exogenous: \_cons

### 4.3. VAR model

The complex relationships between SP<sub>r</sub>, BETr, and PCR<sub>r</sub> are explored here by the regression analysis, which reveals the interdependence between these. The findings show that the lagged values of BETr and SP<sub>r</sub>'s historical values have the most powerful impact. A corrective or stabilizing process, in which abnormalities in SP<sub>r</sub> are partially rectified in later periods, may be indicated by the negative coefficient on the first lag of SP<sub>r</sub> (-0.218, significant at the 1% level). This might be a result of market pressures pushing SP<sub>r</sub> back towards a mean or equilibrium level. On the other hand, the presence of a delayed positive feedback loop is suggested by the positive coefficient on the second lag of SP<sub>r</sub> (0.225, significant at the 1% level), which may indicate persistence or momentum in SP<sub>r</sub>'s dynamics following an initial adjustment. The findings show that BETr has a considerable interaction with SP<sub>r</sub>'s lagged values as well as with its own lagged values. A corrective mechanism or mean-reverting behavior in BETr is suggested by the initial lag of BETr (-0.248, significant at the 1% level), which exhibits a negative impact on itself. A pattern like this could point out a short-term overreaction followed by several changes. Furthermore, the positive coefficients of both the first (0.108, significant at the 1% level) and second lag (0.174, significant at the 1% level) demonstrate that SP<sub>r</sub> has a large and long-lasting favorable impact on BETr. This suggests that historical changes in SP<sub>r</sub> have a long-term effect on BETr, maybe due to spillover effects or interrelated market dynamics.

With its own historical values and the lagged values of SP<sub>r</sub> and BETr mainly falling out of statistical significance, PCR<sub>r</sub>, on the other hand, seems to be isolated from the system. This lack of significance implies that either PCR<sub>r</sub> has a weak and indirect association with the other variables, or it may be impacted by external factors not included in this model. As an illustration of the low autocorrelation in PCR<sub>r</sub>, the coefficients for lagged PCR<sub>r</sub> in its own equation (-0.0914 and 0.0300) are negligible.

This result suggests that more research on the factors influencing PCR<sub>r</sub> is necessary, either by including more variables into the analysis, or by considering different econometric strategies. Therefore, the vector autoregressive (VAR) model highlights the complex connections between SP<sub>r</sub> and BETr, which are both under the influence of contemporaneous and lagged effects. Potential feedback loops, mean-reverting behaviors, and market interdependencies are all reflected by these dynamics. However, the PCR<sub>r</sub> limited participation to the system could be explained by the fact that it might function as an exogenous variable, or it might be influenced by other mechanisms, which calls again for more research.

**Table 4.** Vector Autoregressive (VAR) Model Results for Stationary Variables: S&P 500 Returns (SPr), BET Index Returns (BETr), and Put-Call Ratio Returns (PCRr).]

	(1) SPr
SPr	
L.SPr	-0.218** (0.0683)
L2.SPr	0.225** (0.0845)
L.BETr	0.512*** (0.104)
L2.BETr	0.0279 (0.120)
L.PCRr	-0.00220 (0.00681)
L2.PCRr	0.000714 (0.00751)
Constant	1.178 (1.492)
BETr	
L.SPr	0.108*** (0.0300)
L2.SPr	0.174*** (0.0371)
L.BETr	-0.248*** (0.0455)
L2.BETr	0.0742 (0.0528)
L.PCRr	-0.00185 (0.00300)
L2.PCRr	0.00669* (0.00330)
Constant	-0.435 (0.656)
PCRr	
L.SPr	0.395 (0.502)
L2.SPr	-0.378 (0.620)
L.BETr	0.914 (0.760)
L2.BETr	0.982 (0.882)
L.PCRr	-0.0914 (0.0500)
L2.PCRr	0.0300 (0.0551)
Constant	44.55*** (10.96)
Observations	273



#### 4.4. Matrix of correlations

The relationships between the variables SPr, BETr, and PCRr can be also analyzed by the correlation matrix. The correlations are all near zero, indicating that there are little to no linear relationships between these variables. None of the pairs of variables are strongly correlated, meaning that they are likely to move independently. A negative slight correlation, as seen between SPr and BETr, and between SPr and PCRr, indicates that when one variable increases, the other tends to decrease. A positive correlation, as seen between BETr and PCRr, suggests that the relationship is very weak as one variable increase and the other tends to increase as well. This weak correlation reduces the possibility of multicollinearity, which is an important condition in all regression models, i.e. stating whether the explanatory variables are likely to vary significantly.

**Table 5.** Correlation Matrix for Stationary Variables: S&P 500 Returns (SPr), BET Index Returns (BETr), and Put-Call Ratio Returns (PCRr)

Variables	(1)	(2)	(3)
(1) SPr	1.000		
(2) BETr	-0.106	1.000	
(3) PCRr	-0.073	0.022	1.000

#### 4.5. Impulse-response function

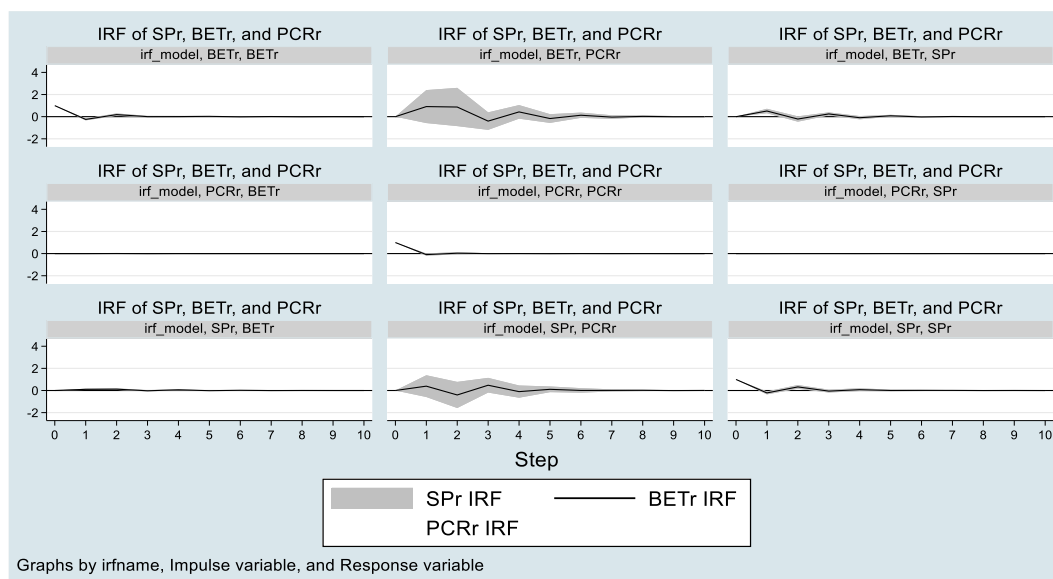
In Figure 0.6 we present the impulse-response function (IRF) charts (Figure 0.6) which show the response of variables to exogenous shocks or innovations in other variables. The direction, amplitude, and duration of these interactions are revealed by the IRFs, which provide crucial insights into the interdependencies among SPr, BETr, and PCRr by tracking the impact of a one-unit shock in one variable on the others.

Short-term oscillations near zero define SPr's reaction to a shock in PCRr. Before stabilizing close to zero, SPr first shows a positive reaction that is swiftly followed by a modest negative response. According to this pattern, shocks in PCRr may cause temporary volatility in SPr, but they do not have long-lasting impacts. This pattern suggests that PCRr-induced shocks cause temporary volatility in SPr, but do not have lasting effects, consistent with Romania's market dynamics, where investor sentiment indicators may be muted due to structural constraints like low market depth. A brief positive response is followed by a modest negative reaction, indicating a low and transient effect of PCRr on BETr. The idea that PCRr's impact on BETr is restricted in both magnitude and duration is further supported by the oscillation around zero, which implies that BETr is comparatively insensitive to shocks caused by PCRr. This highlights the limited influence of sentiment indicators like PCR in Romania's underdeveloped capital market, further constrained by the absence of derivative trading mechanisms supported by the Central Counterparty (CCP).

The PCRr response to a shock in SPr is negative. This significant initial negative impact may reflect how changes in stock performance (SPr) affect investor behavior or market sentiment, as measured by PCRr. The slow drop in significance, however, suggests that the effect is transient and that PCRr will eventually return to its baseline. This steep reaction underlines BET's susceptibility to shocks in SPr, which may reflect its lower resilience to systemic risks compared to developed markets like the S&P 500. A sharply positive response that progressively wanes over time is BETr's quick and steep response to a sudden shift in SPr. This implies that an instantaneous rise in BETr is linked to positive shocks in SPr, which are a sign of better stock performance.

Even if the impact would be initially significant, it cannot be sustainable over time, as evidenced by the return to zero over time. This behavior illustrates the market's propensity to return to equilibrium, a key feature of BET's emerging market dynamics, where external shocks are absorbed relatively quickly but do not leave lasting structural impacts.

**Figures 0-4.** Impulse-Response Functions Depicting the Dynamic Interactions Between S&P 500 Returns (SPr), BET Index Returns (BETr), and Put-Call Ratio Returns (PCRr) Following Exogenous Shocks.]



#### 4.6. Granger Causality test

The test results show that SPr and BETr have a bidirectional Granger-causal relationship (Table 0-8). There is significant evidence that BETr Granger-causes SPr, as indicated by the chi-square statistic for BETr predicting SPr of 26.142 (p-value < 0.01) and that SPr Granger-causes BETr of 34.272 (p-value < 0.01), respectively.

A dynamic link between stock performance (SPr) and (BETr) is suggested by this bidirectional causality. The interdependence of variables and market performance is

highlighted by the fact that changes in one variable provide valuable insights into future changes in the other. PCRr does not show a substantial Granger-causal effect on SPr or BETr, despite its conceptual significance as a sentiment indicator. The chi-squared statistic, for example, is 4.808 (p-value = 0.090) for BETr and 0.121 (p-value = 0.941) for PCRr predicting SPr. There is no predictive association between the two outcomes since the correlation is not statistically significant. This lack of significance implies that either PCRr's influence is mediated by other unobserved factors or that it functions independently of the dynamics reflected by SPr and BETr in this model. These results underscore the limited role of sentiment indicators like PCRr in predicting market performance in Romania, reinforcing the need for infrastructure like the CCP to enhance market depth and indicator relevance.

As shown in Table 0-8, the chi-squared statistic of 26,461 (p-value < 0.01) is obtained for the SPr equation from the joint test of BETr and PCRr, indicating that these variables together help predict SPr. On the other hand, a chi-squared statistic of 2.735 (p-value = 0.603) for PCRr (in its own equation), confirms its weak predictive role in this system. The joint significance of considering both variables in the models of market dynamics is shown by the bidirectional Granger causality between SPr and BETr. This finding emphasizes the interconnectedness of stock performance and risk metrics, reflecting the mutual feedback loops that characterize emerging markets like BET.

Although PCRr may be used as a general market sentiment indicator, its direct impact on stock performance (SPr) or risk (BETr) is minimal in the context analyzed here, according to its limited Granger-causal role. This independence is consistent with earlier correlation matrix results showing poor connections between PCRr and SPr and BETr.

When analyzing the relationship between SPr and BETr, the null hypothesis that there is no Granger causation is strongly refuted by the significance thresholds for the Granger causality tests (p < 0.05, 0.01). To properly assess the real role played by PCR in international stock markets, new modeling approaches may be necessary, such as in nonlinear methods or the incorporation of additional explanatory variables.

**Table 6.** *Granger Causality Test Results Highlighting Predictive Relationships Among S&P 500 Returns (SPr), BET Index Returns (BETr), and Put-Call Ratio Returns (PCRr).]*

Granger Causality Wald tests					
Equation	Excluded	chi2	df	Prob>Chi2	
SPr	BETr	26.142	2	0.000	
SPr	PCRr	0.121	2	0.941	
SPr	ALL	26.461	4	0.000	
BETr	SPr	34.272	2	0.000	
BETr	PCRr	4.808	2	0.090	
BETr	ALL	37.768	4	0.000	
PCRr	SPr	1.007	2	0.604	
PCRr	BETr	2.067	2	0.356	
PCRr	ALL	2.735	4	0.603	

## 5. Discussion

The Romanian market is defined by several structural limitations that significantly impact the predictive utility of sentiment indicators like the Put-Call Ratio (PCR). These include low trading volumes, a limited number of listed companies, and the absence of a developed derivatives market. Such conditions constrain the PCR's effectiveness as a sentiment indicator, as its relevance relies heavily on the presence of active derivatives trading and higher market liquidity. The findings of this study highlight the importance of tailoring sentiment indicators to specific market conditions. In the case of Romania, the structural and behavioral characteristics of the BET index underline the need for caution in interpreting PCR as a reliable tool for market sentiment analysis. The findings of this study, which show a lack of significant connections or causality between the Put-Call Ratio (PCR) and both the S&P 500 and BET indices, can be attributed to several factors. While methodological limitations, such as the reliance on linear models like VAR, may have influenced the results, we believe that the unique structural and behavioral characteristics of the Romanian market play a critical role. These include low liquidity, the absence of derivatives trading, and the concentrated composition of the BET index. To address these limitations, future studies should consider exploring alternative econometric approaches and incorporating a broader range of market-specific variables to capture the complex dynamics at play. The study's conclusions add to the increasing amount of research examining the connection between stock market indexes and the put-call ratio (PCR), especially in developing markets such as the Bucharest Stock Exchange (BSE). Despite being generally accepted as a sentiment indicator in established markets, our findings show that the PCR has little use in forecasting or elucidating the BET index (BETr). These results are in line with other research that emphasizes how difficult it is to apply global sentiment indices to developing markets that have distinct structural features. According to our research, PCR has no discernible predictive ability for either the BET index returns (BETr) or the S&P 500 returns (SPr). This is consistent with the findings of Jena and Dash (2014), who investigated how well the PCR predicted market returns. According to their research, PCR is a more accurate predictor in markets with more sophisticated derivatives trading and over longer time horizons. PCR's predictive ability, however, declines in less liquid markets, which is indicative of structural constraints in those settings. The PCR's function as a contrarian sentiment indicator in mature markets was also highlighted by Whaley (Whaley Robert, 2000). High PCR levels may indicate a market reversal because they are frequently perceived as being overly pessimistic. However, the limited use of derivatives and options trading on the Bucharest Stock Exchange is reflected in the weak predictive association between the PCRr and BETr that we found in our study. In the Romanian context, these market features make it more difficult for the PCR to precisely gauge investor sentiment and forecast market movements. A select group of blue-chip companies, mostly from established industries like utilities, energy, and finance, control much of the BET index. Speculative behavior, which propels PCR in more volatile markets, might have

less impact on these industries. The lack of robust derivatives trading in Romania also hinders the PCR's ability to effectively capture investor sentiment. As highlighted by Houlihan and Creamer (2019), sentiment indicators in markets without extensive derivative instruments tend to underperform, as they lack the trading depth needed to produce meaningful signals. Due to regional political and economic influences, emerging markets frequently display distinctive investment behavior. According to Bohl (Martin Bohl & B, 2011), sentiment indicators like the PCR may be less effective in emerging markets where retail investors dominate trading activity and are more likely to base decisions on fundamental or macroeconomic considerations rather than derivative market sentiment. The results align with broader literature on emerging markets, which emphasizes the need for localized sentiment measures tailored to specific market structures and investor compositions. While the VAR model provides valuable insights, its assumptions of linearity and stationarity may limit its applicability in some contexts. While the VAR model offers a flexible and interpretable approach for analyzing short-term dynamics, its linearity imposes constraints on the depth of insights it can provide. Non-linear relationships, such as those captured by Markov-switching or regime-change models, may uncover additional complexities in the interactions between the PCR and market indices. Future research should explore these advanced econometric approaches to better understand the intricate dynamics present in both developed and frontier markets. Jordà (2005) proposes local projections as an alternative method for estimating impulse responses, which relaxes these assumptions and could be considered in future research (Jordà 2005). Employing advanced econometric techniques, such as regime-switching models or machine learning algorithms, could uncover hidden relationships that are not captured by linear models. In the Romanian context, the absence of a Central Counterparty (CCP) and the resulting lack of advanced derivatives markets amplify these limitations. The development of a CCP would not only enhance market liquidity but also facilitate more sophisticated trading strategies, potentially increasing the relevance of sentiment indicators like the PCR. As emphasized by Amazouz (2022), improving financial infrastructure in emerging markets can significantly enhance the applicability of traditional sentiment tools. Future research could benefit from employing advanced econometric techniques, such as re-game-switching models or machine learning algorithms, to uncover hidden relationships that may not be captured by linear models. Machine learning approaches have shown promise in analyzing sentiment indicators in complex and evolving market environments (Blau & Brough, 2015; Fang et al., 2014). These methods could help identify non-linear dynamics and offer deeper insights into the interplay between sentiment and market performance.

## 6. Conclusions

The results of this paper are expected to shed some light on the relationship and bicausalities between the PCRr, BETr, and SPr. The dynamics of these variables and their interactions have been addressed by an econometric framework that includes correlation

analysis, impulse-response functions (IRFs), and Granger causality tests. The PCR<sub>r</sub> and SP<sub>r</sub> are found to be linked by a negative connection, suggesting that increases in PCR are correlated with the decrease of stock index performances. As a sentiment indicator, the PCR is frequently viewed as a contrarian signal in equity markets, which is consistent with earlier research (Whaley Robert, 2000). However, the absence of a significant correlation between PCR and BET offers important insights within the unique context of the Romanian market. This reflects structural limitations, such as the lack of developed derivatives markets and the concentrated structure of the BET index. These findings emphasize the limited utility of sentiment indicators like PCR in emerging markets, where structural constraints play a critical role in shaping their relevance. The impulse-response study, however, shows that shocks to SP<sub>r</sub> have a substantial negative effect on PCR, which will eventually end up decreasing. This aligns with findings that market sentiment indicators are less effective in environments with low market liquidity and limited access to derivative instruments (Amazouz, 2022). This emphasizes the transient character of these processes in the sense that although there are short-term interactions, the relationship is not persistent. The correlation analysis and Granger causality tests repeatedly show here that there is no substantial predictive association between the put-call ratio and the returns of the BET index or the S&P 500.

These findings raise concerns about the accuracy of using PCR as a prediction tool for market players, particularly in the context of the Bucharest Stock Exchange, where the PCR appears to not be an accurate and significant predictor of market movements. The interdependence of regional and international financial markets is highlighted by the bidirectional Granger causality between BET<sub>r</sub> and SP<sub>r</sub>. This conclusion underscores the necessity of incorporating cross-market dynamics when analyzing indexes and devising investment strategies.

The effects of shocks are most noticeable in the short term after the shock, but they tend to level out over time, according to the impulse-response functions. The system's resilience and propensity to return to equilibrium are reflected by this pattern. Market players and portfolio managers should be prudent when using only the PCR indicator due to its poor forecasting ability. Predictive accuracy may be improved by including more indicators, such as macroeconomic factors or volatility indices (like the VIX).

PCR and SP<sub>r</sub> are in a moderately inverse relationship, which could reflect stock market behavioral tendencies like overreaction or herd mentality. Strategies to take advantage of market inefficiencies could be influenced by these observations. The absence of meaningful correlations between PCR and the BET index suggests that the Romanian and American markets may differ in terms of investor behavior or market structure. These discrepancies could be thoroughly examined in future research. For both strategic investment and econometric research, this empirical analysis provides a basis for well-informed financial and economic decision-making.

According to our results, PCR is not very useful as a forecasting tool for market players, especially those who trade on the Bucharest Stock Exchange. To provide more reliable insights into the market dynamics, future studies should examine how PCR interacts with other volatility and sentimental indices. The absence of meaningful correlations between the PCR and the BET index suggests that the Romanian and US markets may differ in terms of investor behavior or market structure. These discrepancies could be thoroughly examined in future research. Expanding the dataset to include more recent data could provide additional insights into the evolving dynamics between the PCR and market indices, particularly considering significant events such as the COVID-19 pandemic. Future research should consider extending the analysis period to capture these broader trends and assess the robustness of the findings under varying market conditions.

When analyzing the predictive dynamics of sentiment indicators in developing European markets, Badea et al. pointed out that structural variations in these markets, like a lack of depth in options trading, can make indicators like the PCR less relevant (Leonardo Badea; Daniel Stefan Armeanu; Iulian Panait and Stefan Cristian Gherghina, 2019). These results highlight once again the necessity of placing the PCR forecasting accuracy in the context of the unique features of the Romanian market and the BET index. The dominance of sector-specific blue-chip companies in the Bucharest Stock Exchange and the underdevelopment of derivatives may be the reasons behind the PCR poorer predictive. These findings raise questions about the broader utility of the PCR in emerging markets and its role as a standalone sentiment indicator. Recent research suggests that integrating macroeconomic variables, such as GDP growth and volatility indices (e.g., the VIX), could enhance predictive accuracy, particularly in markets undergoing rapid evolution like Romania (Blau & Brough, 2015; Tsukahara & Tsuchimura, 2021). Policymakers should prioritize the development of financial infrastructure, such as the Central Counterparty (CCP), to improve market liquidity and enable the effective use of sentiment indicators. Future research should explore how the introduction of derivative instruments in Romania might influence the relationship between sentiment indicators and market performance. Comparative studies between emerging and developed markets could provide further insights into the structural and behavioral factors influencing PCR's effectiveness. Expanding methodological frameworks to include non-linear models, alternative sentiment indicators, and region-specific variables could yield more nuanced findings. While the study provides valuable insights into the relationship between the Put-Call Ratio (PCR) and market indices, it is not without limitations. The analysis is constrained by the lack of a developed derivatives market in Romania, the assumption of linear relationships in the VAR model, and the limited temporal scope. Future research could address these gaps by incorporating data from Romania's emerging derivatives markets once operational, exploring nonlinear models, and integrating sentiment analysis tools rooted in behavioral finance. Additionally, comparative analyses between emerging and mature markets could enhance the understanding of PCR dynamics across different market structures. These

extensions would further contribute to the development of robust investment strategies and market risk management frameworks. While this study focused on the relationship between the PCR and market indices, future research could benefit from incorporating additional variables that may influence these dynamics. Macroeconomic factors such as GDP growth, inflation, and interest rates could provide context for understanding broader market trends. Additionally, market-specific variables like liquidity levels and alternative investor sentiment indicators could further enhance the analysis. These additions would allow for a more nuanced understanding of the interplay between the PCR and market indices, particularly in various market environments.

In conclusion, this study highlights the importance of contextualizing sentiment indicators like PCR within the structural realities of different markets. While the PCR demonstrates some utility in developed markets like the U.S., its role in emerging markets remains constrained by structural and behavioral factors. Addressing these gaps through targeted policy interventions and further empirical research is essential for improving market efficiency in Romania.

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## Macro-economic determinants of financial inclusion: evidence from West African Economic and Monetary Union (WAEMU)

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**Abstract.** *The aim of this paper is to identify the main macroeconomic determinants of financial inclusion in the WAEMU over the period 2007-2020. Our estimation results from GLS and RE reveal that income per capita, education, mobile phone access and gross fixed capital formation positively and significantly affect financial inclusion in WAEMU. However, our results show that final household consumption expenditure and the share of the population living in rural areas have a negative and significant impact on financial inclusion in WAEMU. This suggests the need to strengthen the financial education of populations, as well as investment in adequate infrastructure in rural areas, likely to attract investors from the financial system.*

**Keywords:** financial inclusion, panel data, GLS, WAEMU.

**JEL Classification:** C23, C59, G21, G23.

## Introduction

The issue of financial inclusion has occupied a prominent place in the design and implementation of development policies since the late 1990s. For this reason, the Central Bank of West African States (CBWAS), along as most international institutions, considers universal access to finance as one of the pillars of empowerment for vulnerable groups. Theoretically, underdevelopment is linked to the inability to mobilize resources, which is characteristic of an inadequate or non-existing financial system (Bagehot, 1873). Schumpeter (1911) argued that financial services, and bank loans in particular, were indispensable to economic growth insofar as they improved productivity by encouraging technological innovation.

In literature, recent efforts have been made to theorize financial inclusion. Indeed, given that no theory of financial inclusion has been developed in the policy or academic literature, despite the growing interest of researchers in the issue, Ozili (2020) proposes a categorization of ideas and perspectives on financial inclusion into three groups of theories. These include theories of beneficiaries, providers and financing theories of financial inclusion. Later, Ozili (2023) develops an institutional theory of financial inclusion that should strengthen the capacity of financial inclusion theories to deal with often more complex external phenomena.

With regard to its effects on beneficiaries and hence on the economy as a whole, research shows that financial inclusion promotes economic growth (Demirguc-Kunt and Levine, 2009; Demirgüç-Kunt et al., 2007; Levine, 2005; Levine, 1997). It also reduces inequality and poverty, while raising the living standards of the poor (Beck et al. 2007; Kempson, 2006). Therefore, well-organised financial systems would have positive effects on economic growth, particularly in the long term.

There are arguments in the literature about the factors that may condition access and use of financial services. For Tuesta et al. (2015), a large number of non-financial factors such as telecommunications development, individual characteristics, cultural issues and policy implementation, among others, condition the use and quality of financial services. Financial inclusion can also be seen as a function of both structural and policy factors (Naceur et al., 2015; Evans and Adeoye, 2016). According to these authors, structural characteristics are related to population size and density, income per capita and the degree of informality in the economy. Policy factors, especially the degree of macroeconomic stability and the institutional framework, affect the costs and financial services delivered.

In WAEMU (West African Economic and Monetary Union), despite the measures taken by some governments to promote financial inclusion, efforts still need to be made. According to BCEAO (2021), in 2019, less than 20% of the adult population had access to basic banking services. In fact, the binarization rate in the narrow sense for the adult population has gone from 9.69% in 2009 to 18.027% in 2019. This low rate of access to banking services in the narrow sense is observed in all countries of the Union. The broader binarization rate, including local financial systems, has gone from 22.94% to 41.05%. This indicates that more than half the WAEMU population is still excluded from the financial system. The overall rate of use of financial services by the adult population remains below

expectations, although it has improved significantly in recent years due to mobile money services. This indicator has risen from 19.66% in 2009 to 71.66% in 2019 (BCEAO, 2021). This finding highlights the issue of the main determinants of financial inclusion in WAEMU. In other words, what are the main determinants of financial inclusion in WAEMU?

In recent economic literature, the analysis of the determinants of financial inclusion has been the subject of several empirical studies. Indeed, in a macroeconomic approach, most studies (Evans and Adeoye, 2016; Oyelami et al., 2017) agree that income per capita, the literacy rate and banking innovation have a significant and positive impact on financial inclusion. Furthermore, most studies based on a microeconomic approach emphasize the role of individual characteristics in explaining people's access to the formal financial system. They also conclude that the level of literacy, wealth and distance from financial service points significantly determine financial inclusion (Akudugu, 2013; Yakubu et al., 2017).

In WAEMU, some studies have focused on the issue of financial inclusion (Lanie, 2017 and Senou et al., 2019). Indeed, Lanie (2017) focusing on the determinants of demand and self-reported barriers to financial inclusion in WAEMU found that age, gender, employment status, education level and income are fundamental determinants of financial inclusion in WAEMU. Senou et al (2019) investigated the role of digital technologies on the dynamics of financial inclusion. Their results showed that the use of mobile phones and internet together is essential for financial inclusion in WAEMU countries. However, the literature has rarely examined the determinants of financial inclusion in its various dimensions (access, use and affordability of financial services).

This research fills this gap by examining the determinants of both the synthetic financial inclusion index and the dimensions and indicators of financial inclusion. We hypothesize that each dimension and indicator of financial inclusion has its own determinants, which are not necessarily those of the synthetic index of financial inclusion.

This paper provides two key contributions to the literature on the macroeconomic determinants of financial inclusion. Firstly, to our knowledge, it is the first study to examine both the determinants of financial inclusion as a whole, and those of its dimensions and indicators. Secondly, we construct the dimensions and the synthetic index of financial inclusion using the approach of Wang and Guan (2017) and then proceed with a regression analysis using generalized least squares (GLS) and random effects (RE). This provides insight into the main determinants of financial inclusion in the UEMOA.

The rest of the paper is structured as follows: Section 2 provides a brief literature review the determinants of financial inclusion. Section 3 outlines the methodology and data used in the analysis. Section 4 presents and discusses the main results, including robustness tests. Finally, Section 5 concludes.

## 1. Literature review

The purpose of this section is to highlight the theoretical and empirical work that has already been done on the determinants of financial inclusion. In this section, we first draw a distinction between financial inclusion and financial development. Secondly, we look at

the various theoretical arguments developed around the factors likely to influence access to and use of formal financial services by economic agents. Finally, we focus on empirical work related to the determinants of financial inclusion.

### **1.1. Conceptual aspects**

This section aims to highlight the theoretical and empirical work already carried out on the determinants of financial inclusion. Firstly, we make a distinction between financial inclusion and financial development. Next, we look at the theoretical underpinnings of financial inclusion.

#### **1.1.1. Financial inclusion and financial development: what distinction should be made?**

Over time, researchers have focused much more on the role of a deep financial system (financial development) in the process of economic growth. But today, both researchers and public authorities are paying particular attention to financial inclusion. This shift towards financial inclusion rather than financial development could be explained by the fact that, according to Cull et al (2012), deep financial sectors are not necessarily accessible to everyone when financial services are almost entirely the preserve of the rich. So, what distinction can we make between financial inclusion and financial development? Researchers have been able to shed some light on this question. Some have looked at the definition of the two concepts, while others have tackled the meaning of the relationship between financial inclusion and financial development.

##### **1.1.1.1. Distinction in view of definition**

The concept of financial development has evolved considerably over time. Shaw (1973) defined it as “*the accumulation of financial assets at a faster rate than the accumulation of non-financial assets*”. For Levine (2005) “*financial development occurs when financial instruments, markets, and intermediaries reduce, but do not necessarily eliminate, the costs of obtaining information, the costs of executing contracts, and the costs of transactions, and therefore do a better job of providing five financial functions*”. The five financial functions whose improvement implies financial development, according to Levine (2005) are: (i) *producing ex-ante information on projects and promoting the optimal allocation of resources*, (ii) *monitoring investments and controlling companies*, (iii) *facilitating financial transactions, hedging against risks, diversifying assets and pooling risks*, (iv) *ensuring the mobilization of savings* and (v) *facilitating the exchange of goods and services*.

Hlophe (2018) defines financial development as improving the size, efficiency and stability of the financial system. For the same author, financial inclusion means that individuals and businesses have access to affordable financial products to meet their needs.

##### **1.1.1.2. Link between financial inclusion and financial development**

Researchers have generally supported the argument that financial inclusion is a component of financial development (Lenka, 2021; Hlophe, 2018; Rasheed et al., 2016). Indeed, Lenka (2021) argues that financial inclusion is an integral dimension of financial development, as well as economic growth. Consequently, affordable and transparent financial products and services are useful for the development of the financial sector.

Based on the premise that developing countries can be financially developed for many reasons, but not always financially inclusive due to high income inequality, Ozili (2020) and Rasheed et al. (2016) argue that financial inclusion is a fundamental determinant of financial sector development. Thus, according to Rasheed et al (2016), increasing financial inclusion could lead to financial development and hence economic development. For Sarma (2008), policymakers are trying to establish inclusive financial systems in developing countries because financial development is sustained in the long-term when all people have better financial access.

### **1.1.2. Theoretical foundations of financial inclusion**

In the literature, financial inclusion has only recently been theorized. Indeed, based on the observation that no theory of financial inclusion has been developed in the policy or academic literature, Ozili (2020) proposes a categorization of theories of financial inclusion into three groups, namely: financial inclusion beneficiaries, theories of providers (FS suppliers) of financial inclusion and financing of financial inclusion. Next, Ozili (2023) develops a new theory called the institutional theory of financial inclusion with a view to ensuring the capacity of financial inclusion theories to deal with more complex external phenomena.

#### **1.1.2.1. Theories of the beneficiaries of financial inclusion**

In the literature, the question of the beneficiaries of financial inclusion has given rise to contradictory ideas among researchers. Indeed, some studies argue that the poor are the ultimate beneficiaries of financial inclusion (Bhandari, 2018), others believe that women are the beneficiaries of the effects of financial inclusion (Ghosh and Vinod, 2017; Demirguc-Kunt et al., 2013b; Swamy, 2014) while some believe that the economy and the financial system are the beneficiaries of financial inclusion (Mehrotra and Yetman, 2015; Kim et al., 2018; Swamy, 2014; Ozili, 2018). For Ozili (2020), young people, the elderly, institutionalized people, people with disabilities and individuals excluded from the financial system due to criminal offences are also potential beneficiaries of financial inclusion. These different approaches to the beneficiaries of financial inclusion have led Ozili (2020) to formulate four theories to better explain who benefits from financial inclusion. The first considers formal financial services as public goods that must be provided to everyone for the benefit of all. The dissatisfaction theory of financial inclusion defends the idea that a country's FI programs should first target all those individuals who previously existed in the formal financial sector but left it because they were dissatisfied with the rules of engagement in the formal financial sector. Whereas, the FI theory of vulnerable groups argues that the focus of a country's financial inclusion programs should be on the vulnerable members of society (such as the poor, the young, women and the elderly) who suffer most from economic hardship and crisis. Thus, to achieve financial inclusion for these groups, Ozili (2020) advocates that the government make social transfers to the formal account of these vulnerable people. Finally, the systemic theory of financial inclusion states that the effects of financial inclusion are achieved through the existing sub-systems (such as economic, social and financial systems) on which financial inclusion relies. Therefore, greater financial inclusion will have positive effects on the sub-systems on which it is based.

### **1.1.2.2. Financial inclusion providers' theories**

As far as the providers of FS are concerned, several arguments have also been put forward on this issue. Some believe that the government should provide formal financial services to the population (Aggarwal and Klapper, 2013; Staschen and Nelson, 2013; Chibba, 2009). Others believe that private companies, such as banks and financial technology companies, can provide formal financial services to the population more efficiently (Gabor and Brooks, 2017; Ozili, 2018). Other ideas suggest that formal financial services can be delivered through cooperation between the public and private sectors (Arun and Kamath, 2015; Pearce, 2011). These expectations about the provision, or supply, of formal financial services require an underlying thought process to establish why these agents are needed in the first place to provide formal financial services. In this regard, Ozili (2020) puts forward five (05) theories or perspectives relating to the provision of FS.

The community-level theory of financial inclusion states that formal financial services should be provided to the excluded population through their community leaders. According to this theory, community leaders are influential within their communities and can use their influence to encourage or persuade community members to join the formal financial sector. The public service theory of financial inclusion argues that financial inclusion is a public responsibility that government owes to its citizens. The government, through its public institutions, has a duty to provide formal financial services to all citizens. This theory responds to Mankiw's (1986) assertion. In fact, Mankiw (1986) believes that financial markets can't operate freely and that state intervention is essential, especially to assume the function of lender of last resort.

Financial inclusion special agent theory defends the idea that formal financial services should be provided to the excluded population by special agents. The rationale for this theory is that the provision of formal financial services to unbanked adults can be difficult due to the nature of remote communities, their population or geography. Thus, the special agent must: (i) be a highly skilled and specialized agent, (ii) understand the particularities of the excluded population, (iii) understand the existing informal financial system in the communities where the excluded members of the population reside, (iv) identify areas for improvement through innovation, and (v) devise a means of integrating the excluded communities into the formal financial system.

Furthermore, the collaborative intervention theory of financial inclusion states that formal financial services should be delivered to the excluded population through a collaborative multi-stakeholder intervention. This theory suggests that a joint effort by several stakeholders is necessary to bring the excluded population into the formal financial sector. Finally, the theory of financial inclusion based on financial literacy focuses on the financial education of citizens. It argues that financial education will increase people's willingness to participate in the formal financial sector.

### **1.1.2.3. Financing theories of financial inclusion**

The issue of how to finance financial inclusion expenditure for the population is a major challenge. Some analysts believe that public money (taxpayers' money) should be used to fund financial inclusion programs (Marshall, 2004). Others believe that private sector



capitalists should fund financial inclusion programs because they have contributed to widening the income inequality gap between the poor and the rich (Mohiuddin, 2015). Other ideas suggest that financial inclusion programs should be jointly funded by the public and private sectors (Dashi et al., 2013; Cobb et al., 2016). Based on these ideas, Ozili (2020) formulates three theories likely to explain the process of financing financial inclusion.

The private money theory of financial inclusion states that financial inclusion initiatives should be privately funded. Ozili (2020) explains this theory by the fact that private funders would: (i) demand greater accountability from the users of their funds, (ii) ensure that private funds are used effectively, and (iii) ensure that formal financial services are provided to excluded members of the population. Whereas the public money theory of financial inclusion argues that financial inclusion programs should be funded by public money. According to defenders of this theory (Ozili, 2020; Dashi et al., 2013) financial inclusion programs should be funded by government budgets. The intervention fund theory of financial inclusion argues that financial inclusion activities and plans should be funded by special interventions from various donors rather than by taxpayers' money.

#### **1.1.2.4. The institutional theory of financial inclusion**

In the literature, several studies have emphasized the effect of institutional quality on the level of financial inclusion (Nkoa and Song, 2020; Ali et al., 2022; Aracil et al., 2022). Based on these results, Ozili (2023) develops an institutional theory of financial inclusion. The latter stipulates that people constantly interact with the formal and informal institutions of society, and their constant interactions with these institutions shape their opinion on whether and how to access formal financial services. People with incomplete information about how to access formal finance will be motivated to interact with trusted informal institutions to obtain more information that forms the basis of their decision-making. These opinions influence their decision to join or remain outside the formal financial sector, which affects the level of financial inclusion.

Well before Ozili (2023), Acemoglu et al (2003) argue that institutional endowments and the proper functioning of institutions can also be determinants of the success of financial policies. With regard to informal finance, Christensen (1993) considers that for informal finance to be viable, certain conditions must be met, in particular: *(i) low transaction, information and management costs; (ii) the existence of minimum reserves to ensure the financial transformation function and the necessary guarantees in the event of default.* According to Kapur (1992), the activities financed by informal loans are often illegal and lenders are not protected in the event of borrower bankruptcy. Thus, for him, informal finance is only used to finance small-scale micro-projects, while recourse to bank financing is indisputable for the financing of major investment and development projects.

### **1.2. Empirical literature review on financial inclusion determinants**

A number of empirical studies have attempted to identify the determinants of financial inclusion. However, most of them have focused on approximating the financial inclusion index with an indicator that could only respond to a single dimension of financial inclusion. Two approaches (notably microeconomic and macroeconomic analysis) have been used in

the literature to identify the factors (supply, demand and institutional) likely to influence people's capacity to be included in the formal financial system.

### **1.2.1. Macroeconomic determinants of financial inclusion**

Some researchers have taken a macroeconomic approach to identifying the determinants of financial inclusion. Through this approach, most of them have been able to point to individual characteristics and certain macroeconomic factors likely to influence the financial inclusion capacity of economic agents. With this in mind, Wokabi and Fatoki (2019) examine a sample of five (5) East African countries over the period 2000-2016. They find that rural population share and income level are the main determinants of financial inclusion in East Africa. At the same time, Gebrehiwot and Makina (2019) adopt the approach advocated by Sarma and Pais (2011) to calculate the financial inclusion index on a sample of 27 African countries over the period 2004-2013. The results of the GMM estimation reveal that the lagged value of the financial inclusion index, per capita income and telephone infrastructure positively and significantly affect the financial inclusion of people in Africa. However, public borrowing from financial institutions negatively and significantly affects the level of financial inclusion of the populations of these countries. Long before Gebrehiwot and Makina (2019), Evans and Adeoye (2016) found that per capita income, literacy rate, the presence of Islamic banks and their activities significantly and positively influence the financial inclusion of populations. They also revealed that the inflation rate and the interest rate on deposits do not influence the level of financial inclusion.

Looking at the specific case of 29 Indian cities over the period 2006-2014, Rajput (2017) finds that per capita domestic product, the proportion of factories and the employee base are significant variables indicating that income and employment lead the public to be more active, aware and interested in banking activities, which contributes to financial inclusion. Following Rajput (2017), Raichoudhury (2020) uses, a panel consisting of 27 Indian states over a period of four (04) years (2012-2015). He finds that income, infrastructure and employment opportunities are perhaps the most important determinants of financial inclusion.

Oyelami et al (2017) investigate the determinants of financial inclusion in sub-Saharan Africa; through a sample of 26 countries over the period 2004-2015. To do so, they use a staggered lag autoregressive model (ARDL) on panel data from the region. The results of the study reveal that financial inclusion in the region is significantly influenced by secondary demand factors, notably income level and literacy, and secondary supply factors such as interest rates and banking innovation through the use of ATMs.

Sarma and Pais (2008) focus on data available from 49 countries in 2004 (cross-sectional data) using the three fundamental dimensions of financial inclusion such as accessibility, availability and use of banking services. The Ordinary Least Squares (OLS) results reveal that per capita income, asphalted roads, mobile telephony and the internet have a positive and significant influence on people's financial inclusion. Foreign assets, on the other hand, have a negative and significant influence on financial inclusion.

### 1.2.2. Financial inclusion determinants: a microeconomic analysis

At the microeconomic level, some researchers have been able to highlight the characteristics likely to influence the capacity of economic agents to be included in the formal financial system. For example, Abdu and Adem (2021) examine the determinants of financial inclusion in the Afar region of Ethiopia. Their results from regressions of data collected from administrative structures using the logistic method reveal that age, financial education and mobile banking services positively affect financial inclusion. In addition, the results reveal that barriers to financial inclusion, notably difficulties accessing credit, interest rates, lack of financial education, lack of internet access, lack of collateral, lack of confidence in financial institutions and difficulties accessing commercial banks and ATMs, are all factors limiting financial inclusion in the Afar region.

Well before Abdu and Adem (2021), Mhlanga and Denhere (2020) attempted to identify the major pillars of financial inclusion in South Africa. To this end, they focus on data taken from the 2018 General Household Survey (GHS) database, composed of 20,000 individuals aged 15-88. Logit estimates show that age, education, income, race, gender and marital status are the main determinants of financial inclusion in South Africa. At the same time, Dar and Ahmed (2020) look at the determinants of and barriers to financial inclusion in India. To do so, they base their analysis on data from the World Bank's financial database (Global Findex, 2017). These data concern a sample of 3,000 people aged over 15. Estimates using the probit method show that gender, age, level of education and income have a significant impact on the different variables used as proxies for the level of financial inclusion in India. These variables also have a significant impact on savings and informal borrowing. Focusing on the Zimbabwean case, Abel et al (2018) find that age, level of education and financial literacy, income level and internet connectivity positively affect financial inclusion. However, documentation required to open a bank account and distance to a financial services access point were found to be negatively related to inclusion in the formal financial system in Zimbabwe.

Lanie (2017) examines the determinants of financial inclusion in the WAEMU, using data from the 2014 global survey. Firstly, the results of the maximum likelihood estimations indicate that individual characteristics including: age, gender, employment status, level of education and income determine financial inclusion in WAEMU. Secondly, the results of the estimation of the relationship between self-reported barriers and individual characteristics show that level of education and income are the main factors which affect financial inclusion in the WAEMU.

In order to identify the possibilities of access to postal services for different social categories of the population, Clotteau and Measho (2016) use survey data collected from 201 Posts worldwide through the Postal Union. The results show that 183 Posts (91%) confirm that, in the majority of cases, the Post accepts all types of customers, whether rich or poor, employed or unemployed, male or female. This fact shows that postal services do not generally discriminate against their customers. In the same way, Rao (2015), conducts a study carried out jointly with UN Women using data from Global Findex (2014). This study shows that, in developing countries, posts that offer account-based services have twice as many female customers as banks, while the financial inclusion rate of women

worldwide is still 7% lower than that of men. At the same time, Zulfiqar et al (2016) examine the relationship between financial inclusion and individual characteristics in Pakistan. Their results from estimating a probit model confirm that education level, income and gender discrimination are determinants of financial inclusion. This highlights that full and easy financial access to all segments of society could help promote and strengthen inclusive and sustainable economic growth for the benefit of all. Jabir (2017) investigates the determinants as well as the effect of financial inclusion on poverty reduction in sub-Saharan Africa. He uses a probit model to analyze data collected from 35 countries and nearly 35,000 individuals. The results show that higher levels of education and income have a positive influence on financial inclusion. They also show that age and age squared are linked positively and negatively respectively on the level of financial inclusion.

Peña et al (2014) examine the determinants of financial inclusion in Mexico, to establish a correspondence between the indicators credit and productive savings. To do this, they use the general linear regression model to analyze World Bank 2012 survey data. Their estimates lead them to conclude that individual characteristics, especially age, geographical location of the household, education and marital status, have a significant influence on the inclusion in the formal financial system of populations with a high level of education.

Clamara et al (2014) investigate the factors determining the likelihood of financial inclusion of households and businesses in PERU. They use a quantitative approach to determinants based on micro survey data. Significant correlation is used to identify the determinants of financial inclusion in PERU. Their results show that vulnerable groups (women and individuals living in rural areas) are more exposed to difficulties in accessing the formal financial system.

Beck et al (2007) try to measure financial inclusion and identify its determinants. They use survey data from 99 countries. These authors measure financial inclusion using the number of branches and ATMs in relation to the population and the geographical and demographic penetration ratio of the banking system. They find that a high number of bank branches and ATMs is interpreted as a broadening of the opportunities for people and businesses to access the banking system in these countries.

Akudugu (2013) examines the determinants of financial inclusion in West Africa with a particular focus on Ghana. In his analysis, this author uses data collected from 1,000 adults in Ghana and includes different wealth classes, occupations, geographical locations, gender and generations. Using the logit model, he estimates that: the age of individuals, literacy level, wealth level, distance from financial institutions, lack of documentation, lack of confidence in institutions, monetary poverty and social networks as reflected in family relationships are the significant determinants of financial inclusion in Ghana. Subsequently, Yakubu et al (2017) analyze the determinants of financial inclusion in Northern Ghana, using primary survey data. The results obtained, based on the estimation of a discriminant function model, show that the most significant determinants of financial inclusion in northern Ghana (in order of importance) are 'age', 'cost of financial services', 'capacity', 'literacy', 'distance' and 'employment'.

Soumaré et al (2016) analyze the determinants of financial inclusion in Central and West Africa. Their analysis using logit and probit methods of data from the World Bank database (Global Findex, 2011) on 18 countries (including 10 from ECOWAS and 8 from ECCAS, with a sample of 1,000 respondents per country) indicates that access to formal finance in both regions is mainly determined by individual characteristics such as gender, education, age, income, area of residence, employment status, marital status, household size and degree of trust in financial institutions. In addition, they find that education level and place of residence are important individual characteristics of access to a formal account in both regions and in Africa. However, being male and/or married are positive determinants of financial inclusion for Central Africa and the continent as a whole, while income is important in West Africa and Africa as a whole. In addition, household size has a negative impact on account ownership in West Africa and not in Central Africa.

Tuesta et al (2015) use a microeconomic perspective to analyze the three dimensions (access, use and barriers) that determine financial inclusion in Argentina. Analysis of data from the World Bank's Global Findex database in 2012 reveals that, in terms of supply, formal financial services are accessible through channels including bank branches and ATMs, with regulation for financial inclusion still in its infancy, unlike the situation in its neighbors. In terms of use, a person's level of education, income and age are all important variables that determine whether or not they hold financial products such as accounts, credit and debit cards, formal credit and electronic payments. Finally, the factors affecting the perception of the different barriers to involuntary exclusion are: income and age. At the same time, Kimutai (2015), looking at the Kenyan rural environment (Marakwet), based on the results of descriptive statistics and statistical inference, concludes that financial education, infrastructure, internet access and the quality of branches all play a role in explaining the problem of financial inclusion in Marakwet.

Using the World Bank Group's Global Findex 2014 database on 37 African countries, Zins and Weill (2016) set out to examine the determinants of financial inclusion in Africa. The probit analysis of these data reveals that individual characteristics are significantly linked to financial inclusion. In fact, being a woman considerably reduces the probability of having a formal account or formal savings, while no significant result is observed for formal credit. Age has a non-linear relationship with the three financial inclusion indicators, with a positive and significant coefficient for age and a negative and significant coefficient for age<sup>2</sup>. Consequently, older people are more likely to be financially included, but after a certain age, the probability of being financially included decreases. In addition, higher income is associated with greater financial inclusion. The income dummy variables are all significantly negative for all three indicators of financial inclusion, with higher coefficients for the income quintile dummy variables indicating income. Education is positively associated with all indicators of financial inclusion. This leads them to conclude that education and income are the most important individual characteristics explaining inclusion in the formal financial system.

Based on a review of the empirical literature, we find that few studies to our knowledge, particularly at the macro level, have managed to capture both the determinants of financial inclusion as a whole and those of its various dimensions and indicators. This research aims

to fill this gap. It identifies the macroeconomic factors that can have a simultaneous impact on financial inclusion as a whole, as well as on its dimensions and indicators in the WAEMU area.

## 2. Methodology

This section focuses on the methodological approach applied in this study. It details the measurement of financial inclusion, presents the empirical model, and describes the nature and sources of the data.

### 2.1. Measuring financial inclusion: Process used to calculate the index of financial inclusion (IFI)

In the literature, certain studies (Beck et al., 2007; Sarma, 2008; Sarma and Pais, 2011; Camara and Tuesta, 2014; Wang and Guan, 2017) have attempted to demonstrate how to measure financial inclusion. However, the proposed methods for calculating financial inclusion indicators have faced criticism, highlighting their limitations.

Therefore, in our study, we follow the method proposed by Wang and Guan (2017). Our FII is constructed as a multidimensional index and incorporates information on the three main dimensions of financial services: access (Access), usage (Usage), and price accessibility (Price\_Access). The methodology proposed by Wang and Guan (2017) not only estimates the weight of each indicator in forming the different dimensions of financial inclusion but also provides weighting for each dimension in the calculation of the overall index<sup>(1)</sup>.

It should be noted that the BCEAO (Central Bank of West African States) uses principal component analysis (PCA) in its calculation of the synthetic financial inclusion index, drawing inspiration from the work of Camara and Tuesta (2014). Camara and Tuesta (2014), in fact, construct a multidimensional financial inclusion index composed of three dimensions through PCA. However, the PCA used by these authors only measures linear relationships between explanatory variables.

The construction of our financial inclusion index, in line with the approach proposed by Wang and Guan (2017), requires the prior transformation of each indicator using the following formula:

$$x_{ij} = \frac{A_{ij} - m_{ij}}{M_{ij} - m_{ij}} \quad (1)$$

where  $x_{ij}$  denotes the transformed value of indicator  $j$  in dimension  $i$  of the FII;  $A_{ij}$  is the current value of the indicator, and  $m_{ij}$  and  $M_{ij}$  are the minimum and maximum values of each indicator, respectively. After transformation, the value of each indicator falls between 0 and 1 ( $0 \leq x_{ij} \leq 1$ ).

Each dimension  $i$  of the IFI, denoted  $ifi_i$ , is calculated using the following formula:

$$ifi_i = 1 - \frac{\sqrt{w_{i1}^2(1-x_{i1})^2 + w_{i2}^2(1-x_{i2})^2 + \dots + w_{in}^2(1-x_{in})^2}}{\sqrt{(w_{i1}^2 + w_{i2}^2 + \dots + w_{in}^2)}} \quad (2)$$

where  $w_{ij}$  represents the weight of indicator  $j$  ( $j = 1, 2, \dots, n$ ) within dimension  $i$  ( $i = 1, 2, 3$ ). In this article, unlike Sarma (2011), who assigned standard weights to different indicators and dimensions, we calculate the weight using an objective weighting method called the coefficient of variation (CV). The CV was originally used in probability theory and statistics to measure the dispersion of a probability distribution or frequency distribution. It is defined as the ratio of the standard deviation  $\sigma$  to the mean  $\mu$  (Wang and Guan, 2017).

Thus, the weight of each indicator is defined as the proportion of its CV relative to the total sum of the CVs of all indicators. Accordingly, the weight of indicator  $j$  in dimension  $i$  is given by:

$$w_{ij} = \frac{V_{ij}}{\sum_j V_{ij}} \quad (3)$$

where  $V_{ij}$  is the CV of indicator  $j$  within dimension  $i$ . Then, the final Financial Inclusion Index (FII) is calculated using the following formula:

$$IFI = 1 - \frac{\sqrt{w_1^2(1-ifi_1)^2 + w_2^2(1-ifi_2)^2 + w_3^2(1-ifi_3)^2}}{\sqrt{(w_1^2 + w_2^2 + w_3^2)}} \quad (4)^{(2)}$$

## 2.2. Specification of the Empirical Model

In this study, we aim to analyze the determinants of financial inclusion within the WAEMU region. Based on theoretical and empirical literature (Raichoudhury, 2020; Dar and Ahmed, 2020; Wokabi and Fatoki, 2019; Sarma and Pais, 2011) presented above, which highlights various factors that may influence the inclusion of populations in the formal financial system, we deduce that financial inclusion can be modeled as follows:

$$fincl = f(\log GDP, Remittances, Consumption, Educ, public\_spend, Phone, FBCF, Rural\_pop) \quad (5)$$

With  $fincl$ : represents the vector of various dimensions and indicators (access and usage of financial services) of financial inclusion calculated following the approach recommended by Wang and Guan (2017);  $\log GDP$ : the logarithm of income per capita, with an expected positive sign. Higher income levels are associated with greater financial inclusion;  $Remittances$ : the share of remittances received as a percentage of GDP, expected to have a positive sign. Remittances increase household resources, potentially boosting their financial inclusion;  $Consumption$ : household final consumption expenditures as a percentage of GDP, with an expected negative sign. This choice is based on the idea that consumption is a key component of household income, and an increase in household consumption expenditures could limit their capacity to save, thus affecting their

ability to smooth consumption in the future; *Educ*: the gross primary enrollment rate, with an expected positive sign. This reflects the hypothesis that a more educated population is better equipped to understand the benefits of using financial products and services, indicating a positive relationship with financial inclusion; *Phone*: access to mobile phones, with an expected positive coefficient sign. This variable assesses the influence of recent innovations in mobile telephony, such as mobile banking, on the level of financial inclusion in the WAEMU region; *Pub\_spend*: public expenditures as a percentage of GDP, with an expected positive sign. Public spending can enhance infrastructure and services that promote financial inclusion; *FBCF*: gross fixed capital formation, with an expected positive sign, as investments in capital formation can stimulate economic activity and support financial inclusion; *Rural\_pop*: the share of the population living in rural areas, with an expected negative sign. The use of this variable aims to capture the effect of the distance of populations from urban centers on the level of financial inclusion. Generally, the points of sale for traditional financial services are concentrated in urban areas, which can limit access to financial services for rural populations. As a result, a higher proportion of the rural population is expected to correlate with lower levels of financial inclusion.

$$fincl = (IFI, Access, Use, Price\_access, TGPSFd, TGPSFg, TGUSF, TBS, TBE) \quad (6)$$

With: IFI: the synthetic financial inclusion index; Access, Use, and Price access: denote the dimensions of access, usage, and price accessibility of financial services, respectively; TGPSFd: the total demographic penetration rate of financial services; TGPSFg: the total geographical penetration rate of financial services; TGUSF: the total global usage rate of financial services; TBS: the strict banking rate; TBE: the expanded banking rate.

Given the nature of our data and the size of our sample (number of individuals  $N$  is less than the number of years  $T$ ), we use the generalized least squares (GLS) estimation technique in this study. For the results of the GLS to be valid, the number of years of study ( $T$ ) must be at least as large as the sample size (number of countries  $N$ ), as there must be at least as many observation periods as there are panels. In this study, we have a sample of eight countries and a study duration of thirteen (13) years covering the period from 2007 to 2020.

To this end, the general equation for identifying the main determinants of financial inclusion in the WAEMU can be expressed in the following general form:

$$Y_{it} = \beta_0 + \beta_i X_{it} + \varepsilon_{it} \quad (7)$$

Where  $Y_{it}$  represents the endogenous variable,  $X_{it}$  is the set of explanatory variables,  $\beta_0$  is the constant term,  $\beta_i$  encompasses the parameters, and  $\varepsilon_{it}$  is the error term. The specific modeling focuses solely on the specification of the error term  $\varepsilon_{it}$ . The basic form can be expressed simply as:

$$\varepsilon_{it} = u_i + v_t + w_{it}$$

Where  $u_i$  represents a term that is constant over time and depends only on individual  $i$ ,  $v_t$  is a term that depends only on the period  $t$ , and  $w_{it}$  is a cross-sectional random term.



This study aims to analyze the determinants of inclusion within the WAEMU region. The literature on measuring financial inclusion and analyzing its determinants, although relatively new, continues to grow. Based on the results obtained in previous studies, notably those conducted by Gebrehiwot and Makina (2019) and Evans and Adeoye (2016), our empirical model is given by the following panel equation:

$$\begin{aligned} fincl_{it} = & \lambda_0 + \lambda_1 \log GDP_{it} + \lambda_2 Remittances_{it} + \\ & \lambda_3 Pub\_spend_{it} + \lambda_4 Consumption_{it} + \lambda_5 Educ_{it} + \lambda_6 Phone_{it} + \\ & + \lambda_7 FBCF_{it} + \lambda_8 Rural\_pop_{it} + \varepsilon_{it} \end{aligned} \quad (8)$$

$$i = 1, \dots, N \text{ et } t = 1, \dots, T$$

Where  $i$  refers to the country and  $t$  denotes the period from 2007 to 2020;  $Access_{it}$ ,  $Use_{it}$ ,  $Prix\_Access_{it}$  represent access, use, and price accessibility of financial services, respectively; and  $\varepsilon$  is the error term. A complete list enumerating the definition and source of each variable used in our estimation is provided in Table 1.

### 2.3. Data source

The data used in this research primarily consists of secondary data related to macroeconomic variables. Most of this data, particularly the explanatory variables, was collected from the World Bank database (World Development Indicators 2021). As for the financial inclusion variables, they all come from the BCEAO database (2021). This data pertains to the eight (08) countries of the West African Economic and Monetary Union (WAEMU) and covers the period from 2007 to 2020, depending on the availability of certain relevant data for this research. Table 1 below presents the various variables of our study, their description, and their sources.

**Table 1.** Summary of variables and data sources

Variable	Notation	Description	Data Source
Financial Inclusion Index	IFI	Composite index of the seven (7) financial inclusion variables	Author
Financial Inclusion	TGPSFd	Overall demographic penetration rate of financial services	BCEAO
Financial Inclusion	TGPSFg	Overall geographic penetration rate of financial services	BCEAO
Financial Inclusion	TBS	Strict banking rate	BCEAO
Financial Inclusion	TBE	Expanded banking rate	BCEAO
Financial Inclusion	TGUSF	Overall usage rate of financial services	BCEAO
Financial Inclusion	TIN_c	Nominal interest rate on deposits	BCEAO
Financial Inclusion	TIN_d	Nominal interest rate on loans	BCEAO
Financial Inclusion	Access	Index of access to formal financial services	Author
Financial Inclusion	Use	Index of usage of formal financial services	Author
Financial Inclusion	Price_access	Price accessibility index of formal financial services	Author
Income per Capita	logGDP	Logarithm of income per capita	WDI
Education Level	Educ	Gross enrollment ratio at the primary level	WDI
Remittances	Remittances	Remittances from migrants as a percentage of GDP	WDI
Rural Population	Rural_pop	Share of the population living in rural areas	WDI
Final Consumption	Consumption	Final household consumption expenditures as a percentage of GDP	WDI
Gross Fixed Capital Formation	FBCF	Gross fixed capital formation as a percentage of GDP	WDI
Public Expenditures	Pub_spend	Public expenditures as a percentage of GDP	WDI
Access to Mobile Phones	Phone	Percentage of the population with access to mobile telephony	WDI

**Source:** Authors.

## 2.4. Estimations methods

In the existing empirical literature, several studies on the determinants of financial inclusion have relied on a simple panel approach (OLS) (Raichoudhury, 2020; Toxopeus and Lensink, 2007), and/or dynamic panels (ARDL, GMM) (Oyelami et al., 2017; Evans and Adeoye, 2016; Detragiache et al., 2006). However, to conduct this study, we use the generalized least squares (GLS) and random effects (RE) estimator to identify the determinants of financial inclusion in the West African Economic and Monetary Union (WAEMU). In order for GLS results be valid, the number of study years (T) must be at least as large as the sample size (number of countries N), as there must be at least as many observation periods as panels (Greene, 2012; Beck and Katz, 1995).

In our study, we have a sample of eight countries and a study period of thirteen (13) years, covering the period from 2007 to 2020. This estimation method also makes it possible to resolve heteroscedasticity problems.

## 3. Results and discussions

### 3.1. Preliminary Tests

#### 3.1.1. Unit Root Test

In the context of this research, we use the Maddala and Wu (1999) unit root test. The choice of this test is justified by the fact that it does not necessarily require the panel to be balanced, as our panel is unbalanced (due to missing data in the education variable). The results of the Maddala and Wu (1999) unit root test (see Appendix 3) show that, on one hand, the variables, particularly public expenditures (Pub\_spend) and the proportion of the rural population (Rural\_pop), are stationary at level, hence integrated of order 0. On the other hand, the results indicate that the variables such as the financial inclusion index (IFI), final household consumption expenditures (Consumption), remittances from migrants (*Remittances*), the logarithm of income per capita (logGDP), education level (Educ), and access to mobile telephony (Phone) are stationary in first difference, hence integrated of order 1.

#### 3.1.2. Multicollinearity Test

This test aims to prevent an explanatory variable in our model from being a linear combination of one or more other explanatory variables included in the same model. To this end, we detected that there is multicollinearity between, on one hand, the logarithm of income per capita (logGDP) and the proportion of the rural population (Rural\_pop); and on the other hand, remittances from migrants (*Remittances*) and the logarithm of income per capita (logPIB).

### 3.2. Empirical results on the determinants of financial inclusion in the WAEMU

In this section, we first focus on presenting the results obtained from our estimates using the Generalized Least Squares (GLS) method on the determinants of the composite index of financial inclusion and the dimensions of accessibility and usage of financial services.

Secondly, we discuss the various results regarding the determinants of access and usage indicators of financial services in the WAEMU. Finally, thirdly, we present the robustness test results obtained through the random effects (RE) model.

### **3.2.1. Determinants of the Composite Index and Dimensions of Financial Inclusion in the WAEMU**

In this section, we present, through Table 2, the results of our estimates using the Generalized Least Squares (GLS) method on the determinants of the composite index of financial inclusion, the accessibility of financial services, and the usage of financial services. It presents the coefficients of the variables, their standard deviations, and their significance. The Wald diagnostic test confirms the rejection of the null hypothesis, which states that the overall models are not significant. Thus, our models fit the data used in the study properly.

The results of our estimates reveal that income per capita (logGDP) positively and significantly affects not only overall financial inclusion but also, and importantly, the accessibility and usage of financial services by the populations of the WAEMU region. This finding regarding the role of income per capita on the inclusion capacities in the formal financial system is consistent with the theoretical and empirical literature presented above. Indeed, according to the financial liberalization theory developed by Kinnon and Shaw (1973), savings are a growing function of the economic growth rate. Empirically, these results align with those obtained by several authors in recent studies (Mhlanga and Denhere, 2020; Raichoudhury, 2020; Wokabi and Fatoki, 2019; Gebrehiwot and Makina, 2019). An increase in households' disposable income enhances their capacity to save and consequently their access to the formal financial system and the use of financial products and services offered to them.

Additionally, our results suggest that the level of education positively influences access to, usage of financial services, and overall financial inclusion of the populations. Thus, an educated population may better understand the importance and role of the financial system and engage with it. These results corroborate findings from certain researchers (Abdu and Adem, 2021; Mhlanga and Denhere, 2020; Dar and Ahmed, 2020; Abel et al., 2018; Lanie, 2017).

Our results also indicate that gross fixed capital formation positively influences overall financial inclusion, particularly the accessibility of formal financial services to populations in the WAEMU region. This result aligns with the argument supported by Gurley and Shaw (1967). According to them, the division of labor and the techniques for transferring savings into investment are fundamental determinants of financial development. Furthermore, our results reveal that access to mobile telephony is a fundamental factor for access to, usage of financial services, and overall financial inclusion in the WAEMU. Therefore, enhancing telecommunications infrastructure could promote inclusion in the formal financial system for a significant portion of the population in the WAEMU region. This result is consistent with findings by Sarma and Pais (2011).

However, our results show that final household consumption expenditures (Consumption) negatively and significantly influence access to, usage of financial services, and overall

financial inclusion of the populations in the WAEMU region. This result highlights the burden of final household consumption expenditures on their inclusion capacities in the formal financial system. Indeed, an increase in final consumption expenditures undermines the possibilities of access to and use of financial services for households in the WAEMU region. In any case, governments would benefit from amplifying efforts in favor of financial education.

Moreover, our results indicate that the share of the population living in rural areas (Rural\_pop) negatively and significantly affects the usage dimension of financial services in the WAEMU region. This implies that the distance of populations from various urban centers, which are recognized as having better financial infrastructure, limits their capacity to use financial services in the WAEMU region.

In summary, our results support that, on one hand, income per capita, level of education, and access to mobile telephony positively and significantly affect financial inclusion, particularly the access and usage dimensions of financial services in the WAEMU region. On the other hand, these results indicate that final household consumption expenditures negatively and significantly influence inclusion in the formal financial system of the populations in the WAEMU.

**Table 2.** Results of Estimates on the Determinants of the Composite Index of Financial Inclusion and Dimensions of Access and Use of Financial Services

VARIABLES	IFI		Access		Use	
	(1)	(2)	(3)	(4)	(5)	(6)
<i>logGDP</i>	0.0403*** (0.0150)		0.0436*** (0.0157)		0.0531* (0.0274)	
<i>Remittances</i>	-0.00246 (0.00282)		-0.00238 (0.00306)		0.0100*** (0.00379)	
<i>Consumption</i>	-0.00569*** (0.00118)	-0.00836*** (0.00177)	-0.00609*** (0.00125)	-0.00403*** (0.00105)	-0.0134*** (0.00215)	-0.00699*** (0.00134)
<i>Educ</i>	0.00161*** (0.000421)	0.000997** (0.000454)	0.00123*** (0.000453)	0.00151*** (0.000489)	0.00911*** (0.000549)	0.00901*** (0.000571)
<i>Pub_spend</i>	-0.00139 (0.00373)	3.19e-05 (0.00485)	-0.00243 (0.00392)	-0.00367 (0.00508)	0.0199*** (0.00583)	0.0196*** (0.00603)
<i>Phone</i>	0.00123*** (0.000172)	0.00107*** (0.000272)	0.00128*** (0.000175)	0.00147*** (0.000244)	0.00153*** (0.000462)	0.00162*** (0.000340)
<i>FBCF</i>	0.00593*** (0.00158)	0.00361** (0.00178)	0.00693*** (0.00168)	0.00922*** (0.00183)	-0.000696 (0.00284)	0.00299 (0.00230)
<i>Rural_pop</i>		-0.00168 (0.00117)		0.000342 (0.00114)		-0.00382*** (0.00138)
Constant		0.701*** (0.219)				
Wald chi2(4)	316.61	99.86	159.57	137.15	2486.91	2407.49
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	81	81	81	81	81	81
Nombre de pays	8	8	8	8	8	8

Standard deviations are shown in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ : indicate significance levels of 1%, 5%, and 10%, respectively

Source: Authors.

In this research, the composite index of financial inclusion in the WAEMU has been constructed from seven (07) indicators, including two (02) for the accessibility dimension of financial services, three (03) for the usage dimension of financial services, and two (02)

for the price accessibility dimension. Therefore, in light of the results presented above, what could be the main determinants of the financial inclusion indicators that measure access to and usage of financial services in the WAEMU?

### **3.2.2. Determinants of Access and Usage Indicators of Financial Services in the WAEMU**

Table 4 below presents our results from the generalized least squares on the determinants of the main indicators of financial inclusion in the WAEMU. Models 1, 2, 3, 4, and 5 highlight the determinants of the overall demographic penetration rate of financial services (TGPSFd), the overall geographical penetration rate of financial services (TGPSFg), the overall usage rate of financial services (TGUSF), the strict banking rate (TBS), and the expanded banking rate (TBE).

Our results revealed that income per capita and access to mobile telephony positively and significantly affect the overall demographic penetration rate of financial services, the overall geographical penetration rate of financial services, the overall usage rate of financial services, and the strict banking rate. These results once again confirm the conclusions of previous studies (Mhlanga and Denhere, 2020; Raichoudhury, 2020; Wokabi and Fatoki, 2019; Gebrehiwot and Makina, 2019).

Furthermore, these results support that the level of education positively and significantly influences the overall geographical penetration rate of financial services, the overall usage rate of financial services, the strict banking rate, and the expanded banking rate. Thus, our results align with the conclusions of certain earlier studies, particularly (Abdu and Adem, 2021; Mhlanga and Denhere, 2020; Dar and Ahmed, 2020; Abel et al., 2018; Lanie, 2017).

However, our results indicate that final household consumption expenditures have a negative and significant influence on the overall demographic penetration rate of financial services, the overall geographical penetration rate of financial services, the overall usage rate of financial services, the strict banking rate, and the expanded banking rate. This means that an increase in the final consumption expenditures of populations limits the capacity of economic agents to save and consequently restricts their inclusion in the formal financial system.

Moreover, our results show that the share of the population living in rural areas (rpop) negatively affects the financial inclusion of populations. However, this negative effect of the share of the population living in rural areas is only significant on the overall usage rate of financial services and the expanded banking rate in the WAEMU. Thus, an increase in the proportion of the population living in rural areas reduces the ability of these populations to appropriately use formal financial services. This could be explained by the high concentration of financial institutions in urban centers and, more importantly, the inadequate telecommunications infrastructure in rural areas of the WAEMU. This finding aligns with the conclusions reached by Wokabi and Fatoki (2019). The results of the determinants of the different access and usage indicators of financial services in the WAEMU are recorded in Table 3 below.

**Table 3.** Results of the determinants of Access and Usage Indicators of Formal Financial Services

VARIABLES	TGPSFd		TGPSFg		TGUSF		TBS		TBE	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<i>logPIB</i>	10.32** (5.163)		3.088 (6.815)		7.304*** (2.293)		2.268** (0.884)		1.549 (2.190)	
<i>Remittances</i>	-0.878 (0.869)		-1.755 (1.892)		0.928*** (0.319)		0.245** (0.122)		1.086*** (0.297)	
<i>Consumption</i>	-1.433*** (0.429)	-2.227*** (0.569)	-1.624*** (0.438)	-6.330*** (1.367)	-1.462*** (0.150)	-0.835*** (0.125)	-0.383*** (0.0692)	-0.227*** (0.0446)	-0.678*** (0.167)	-0.376*** (0.107)
<i>Educ</i>	0.152 (0.124)	0.0170 (0.130)	1.104*** (0.294)	3.084*** (0.757)	0.690*** (0.0569)	0.699*** (0.0575)	0.277*** (0.0177)	0.280*** (0.0187)	0.741*** (0.0518)	0.740*** (0.0476)
<i>Pub_spend</i>	0.0460 (1.341)	-0.283 (1.492)			2.053*** (0.466)	2.092*** (0.585)	0.577*** (0.188)	0.395** (0.198)	0.182 (0.464)	0.941* (0.518)
<i>Phone</i>	0.463*** (0.0711)	0.452*** (0.0907)	0.425*** (0.135)	1.562*** (0.340)	0.231*** (0.0422)	0.285*** (0.0330)	0.0308** (0.0149)	0.0596*** (0.0112)	0.0653** (0.0294)	0.0374 (0.0306)
<i>FBCF</i>	1.684*** (0.526)	1.077** (0.549)	1.494** (0.729)	11.66*** (2.774)	0.207 (0.247)	0.816*** (0.225)	-0.189** (0.0916)	-0.0481 (0.0818)	0.170 (0.187)	0.426** (0.179)
<i>Rural_pop</i>		-0.198 (0.374)		-0.233 (1.383)		-0.331** (0.134)		-0.00677 (0.0491)		-0.406*** (0.112)
<i>Interest_rate</i>			1.470 (1.230)							
Constant		179.2** (69.88)								
Wald chi2(6)	188.27	95.75	81.47	101.13	2021.73	2043.28	2477.76	2268.49	1839.83	1961.19
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	81	81	74	88	81	81	81	81	81	81
Nombre de pays	8	8	8	8	8	8	8	8	8	8

Standard deviations are shown in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ : indicate significance levels of 1%, 5%, and 10%, respectively.

Source: Authors.

In any case, we can assert that, on the one hand, income per capita, the level of education, and access to mobile telephony positively and significantly affect the accessibility and usage of financial services in the WAEMU region. On the other hand, these results support that final household expenditures negatively and significantly influence access to and usage of formal financial services among populations in the WAEMU region.

### 3.2.3. Robustness Test: Estimation Using the Random Effects Method (RE)

We test the robustness of our results by changing the estimation method. Indeed, we replace the generalized least squares (GLS) method with the random effects (RE) method. The results recorded in Table 4 confirm the previous results. In fact, an improvement in the level of education, as well as access to mobile telephony, positively and significantly affects financial inclusion (IFI, Access, Usage, TGPSFd, TGPSFg, TGUSF, TBS, and TBE) in the WAEMU region. However, these results support that final household expenditures negatively and significantly influence financial inclusion in the WAEMU region.

**Table 4.** Robustness tests on the Determinants of Financial Inclusion in the WAEMU

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	<i>IFI</i>	<i>Access</i>	<i>Use</i>	<i>TGPSFD</i>	<i>TGPSFG</i>	<i>TGUSF</i>	<i>TBS</i>	<i>TBE</i>
<i>logGDP</i>	0.0247 (0.0593)	0.0421 (0.0725)	0.0492 (0.0543)	2.513 (17.73)	60.41 (93.36)	15.48* (8.369)	1.914 (1.690)	7.142 (7.791)
<b>Remittances</b>		-0.00400 (0.00681)	0.0103** (0.00510)					
<i>Consumption</i>	-0.00796*** (0.00277)	-0.00651 (0.00459)	-0.0137*** (0.00344)	-2.103** (0.829)	-13.02*** (5.027)	-1.181*** (0.307)	-0.301*** (0.0790)	-1.023*** (0.231)
<i>Educ</i>	0.00172** (0.000736)	0.00159* (0.000926)	0.00907*** (0.000694)	0.200 (0.220)	2.656** (1.127)	0.407*** (0.118)	0.283*** (0.0210)	0.316*** (0.0994)
<i>Pub_spend</i>	-0.00211 (0.00867)	-0.00226 (0.0105)	0.0195** (0.00785)	-1.044 (2.592)	-5.917 (20.93)	1.526** (0.732)	0.567** (0.247)	0.416 (0.518)
<i>Phone</i>	0.00120** (0.000592)	0.00128* (0.000688)	0.00155*** (0.000516)	0.473*** (0.177)	1.338* (0.772)	0.293*** (0.0474)	0.0394** (0.0169)	0.143*** (0.0333)
<i>FBCF</i>	0.00642* (0.00342)	0.00879* (0.00455)	-0.000835 (0.00341)	2.099** (1.021)	10.66 (11.72)	0.276 (0.319)	-0.128 (0.0973)	0.246 (0.222)
Constant	0.295 (0.587)	-0.00806 (0.869)	0.0553 (0.651)	110.2 (175.4)	360.3 (1.051)	-47.43 (77.06)	-6.161 (16.72)	24.07 (66.44)
Wald chi2(4)	61.77	50.61	434.58	55.79	952.50	250.76	362.80	183.65
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	81	81	81	81	81	81	81	81
Nombre de pays	8	8	8	8	8	8	8	8

Standard deviations are shown in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1: indicate significance levels of 1%, 5%, and 10%, respectively.

## Conclusion

The purpose of this paper was to investigate the determinants of financial inclusion in the WAEMU. To this end, our study used the generalized least squares (GLS) and random effects (RE) methods. The results of our estimations revealed that per capita income, level of education, access to mobile telephony and gross fixed capital formation positively and significantly affect financial inclusion as a whole, as well as the dimensions of access to and use of formal financial services in the WAEMU. Our results also supported that income per capita, access to mobile telephony, and the level of education positively and significantly influence the overall demographic penetration rate of financial services, the overall geographic penetration rate of financial services, the overall usage rate of financial services, and the strict banking rate in the WAEMU. In any case, increasing income per capita, access to mobile telephony, and access to education promote inclusion in the formal financial system for populations in the WAEMU region.

In contrast, the results revealed that household final consumption expenditures negatively and significantly affect the overall demographic penetration rate of financial services, the overall geographic penetration rate of financial services, the overall usage rate of financial services, the strict banking rate, and the expanded banking rate. Additionally, our results show that the share of the population living in rural areas negatively affects financial inclusion. However, this negative effect of the rural population is only significant for the overall usage rate of financial services in the WAEMU. Furthermore, the results of our estimations indicated that the share of the rural population negatively affects the use of formal financial services in the WAEMU. This result could be attributed to the lack of adequate infrastructure in rural areas, which is necessary to attract investors from the financial sector to these regions.

Today, banking and financial innovations significantly contribute to the financial inclusion process. The importance of these innovations, combined with the commitment of monetary authorities to financial inclusion, raises questions regarding the effects of financial inclusion on monetary policy.

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## Notes

- <sup>(1)</sup> See the appendix 2 for the weight of each dimension in constructing the synthetic financial inclusion index within the WAEMU region.
- <sup>(2)</sup> In this study ifi1, ifi2 and ifi3 represent, respectively, access (Access), usage (Usage), and price accessibility (Price\_Access) of financial services.

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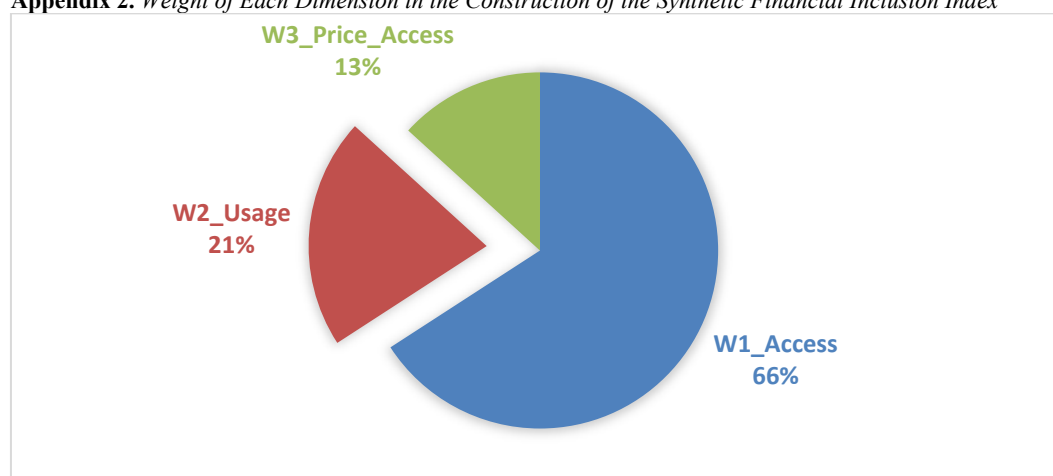
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## Appendix

## Appendix 1. Descriptive Statistics

Variable	Obs	Mean	Std. Dev,	Min	Max
<i>IFI</i>	112	0,1120038	0,133644	0,0145144	0,8785856
<i>Access</i>	112	0,0792997	0,1459152	0,0001223	1
<i>Use</i>	112	0,4163729	0,2432307	0	0,9930962
<i>Price_access</i>	112	0,5115577	0,1893464	0,1427221	0,8683478
<i>logGDP</i>	112	6,689779	0,4512376	6,032479	7,752656
<i>remittances</i>	112	4,615222	3,332478	0,5277326	10,82203
<i>consumption</i>	111	88,33789	6,70341	74,51981	109,533
<i>Pub_spend</i>	103	13,77244	2,777646	7,122182	20,24348
<i>Interest_rate</i>	88	1.839805	4.427838	-23.13794	7.623044
<i>FBCF</i>	111	21,46655	5,959995	6,699039	32,64794
<i>Rural_pop</i>	112	62,28415	10,4417	48,294	83,792

## Appendix 2. Weight of Each Dimension in the Construction of the Synthetic Financial Inclusion Index



## Appendix 3. Maddala and Wu unit root test

Variables	At level		First difference		Decision
	No trend	With trend	No trend	With trend	
<i>ifi</i>	1.1146	2.8493	44.2635***	60.2181***	I (1)
<i>Access</i>	1.1027	3.1357	44.7112***	59.4489***	I (1)
<i>Use</i>	4.1622	8.0664	44.2635***	60.2181***	I (1)
<i>Remittances</i>	15.8105	20.4353	73.7325***	49.0165***	I (1)
<i>logGDP</i>	4.0447	17.6323	85.9525***	60.4257***	I (1)
<i>FBCF</i>	36.4870***	30.7719**	-	-	I (0)
<i>Phone</i>	39.7676 ***	16.6936	65.1258	49.6324	I (1)
<i>Pub_spend</i>	36.2243***	24.7304*	-	-	I (0)
<i>Consumption</i>	23.2343	25.9849*	124.1947***	82.8966***	I (1)
<i>Rural_pop</i>	12.6977	33.7451***	-	-	I (0)
<i>Educ</i>	35.1308***	5.0363	23.9147**	18.9909	I (1)

## Tax and macroeconomic framework. The case of Greece

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**Abstract.** *The aim of this paper is to analyze the impact of taxation in Greece from 1974 to 2018 and highlight key recommendations for policymakers and tax authority to contribute further to strategic planning, revenue capacity, sustainability of public finance and efficient tax administration. The empirical part is vital to analyze and appraise the robustness of tax methodology in a purposeful way, highlight key recommendations for policymakers and tax authority to contribute further to strategic planning, revenue capacity, sustainability of public finance and efficient tax administration in Greece. Overall, the evaluation of the tax changes impact in Greece economy will be examined under the scope of macroeconomic performance and this plays a crucial role in the application of efficient strategies from tax authorities.*

**Keywords:** Greek tax legislation, tax policy, tax reforms.

**JEL Classification:** E62, E63.

## 1. Introduction

In this paper we try to explore the macroeconomic impact of taxation in Greece and highlight key recommendations for policymakers and tax authority to contribute further to strategic planning, revenue capacity, sustainability of public finance and efficient tax administration.

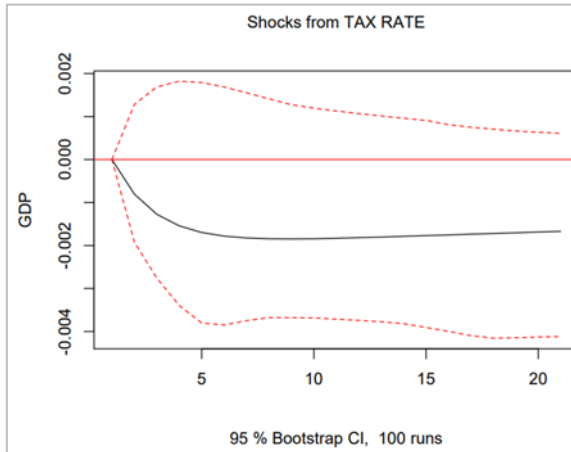
## 2. Literature Review

At first, we focus on a literature review that provides robust evidence on the relationship between tax policy and economic growth. Numerous studies analyze the relationship of taxation and economic growth not only concept of endogenous growth models, but also within the framework of dynamic modeling and the newly developed approach of narrative methods. Indicatively distinguished studies which examined the relationship between tax changes and reforms, tax structure, fiscal policy and their impact on economic growth and other macroeconomic variables included Helms (1985), Barro (1990), Koester and Kormendi (1989), Barro and Martin (1992), Engen and Skinner (1992), Easterly & Rebelo (1993), Pecorino (1994), Alesina and Rodrik (1994), Stokey and Rebelo (1995), Jones et al. (1993), Lehmussaari (1990) and Marsden (1990) and Trella and Whalley (1991, 1992), Barro (1991, 1992) King and Rebelo (1990) Easterly and Rebelo (1993), Devereux and Love (1995), Slemrod (1995), Zee (1996). Also, Alesina and Perotti, (1995), Engen and Skinner (1996), Alesina and Perotti (1995) Padovano and Galli (2001), Gale and Potter (2002), Li and Sarte (2004), Lee and Gordon (2005) and Tosun and Abizadeh, (2005), Moreover, Daveri and Tabellini (2000) Widmalm (2001), Levine and Renelt (1992) J. Agell, T. Lindlh and H. Ohlsson (1996), Jang-Ting Guo and Kevin J. Lansing (1997). Moreover, Mendoza et al. (1997), Gemmell et al., (1999), Myles, (2000), Myles (2009) Steven P. Cassou and Kevin J. Lansing (2003), Daveri and Tabellini (2000), Widmalm (2001) Levine and Renelt (1992), Kerr and MacDonald (1999), Anastasiou and Dritsaki (2005), Myles (2007). Johansson et al. (2008) Arnold et al. (2011). Mendoza et al., (1994) proposed methodology to compute effective tax rates. For relevant studies on effective tax rates and their impact on economic performance see Martinez-Mongay (2000), Carey and Tchilinguirian (2000) and Carey and Rabesona (2002), Trabandt and Uhlig (2011), Papageorgiou et al. (2012). Also see McDaniel (2007), Dellas et al. (2017), Kollintzas, Papageorgiou and Vasilatos (2010). Papageorgiou et al. (2011). Also relevant studies on taxation and economic growth included Pjesky, (2006) Marcellino, (2006) Bania et al. (2007) Reed, (2008). Arnold (2008), K. Angelopoulos, J. Malley, A. Philippopoulos (2008) Gemmell et al. (2011) Ferede and Dahlby, (2012), McBride (2012), Huang and Frenztz (2014), Hungerford (2012) Gravelle (2014). Also, Gemmell et al. (2014). Gale and Samwick (2014) Gale et al. (2015) Li and Lin (2015) Also, Akgun et al. (2017), Galindo (2011) and Blochliger (2015) Jelena et al. (2018) Karras (2019). Zidar (2019) and Alinaghi (2021). As far as dynamic modeling is concerned, it is worth noting that distinguished examples on VAR approaches include Blanchard and Perotti (2002), Barro and Redlick (2011), Perotti (2002). Also, Alesina, et al. (2018) ,Mertens and Olea (2018), Alan et al (2021). Moreover, Mountford and Uhlig (2002, 2009), Hussain and Malik (2016), Jordà and Taylor (2016), Fieldhouse et al. (2017), Stock and Watson (2018), Mertens and Olea

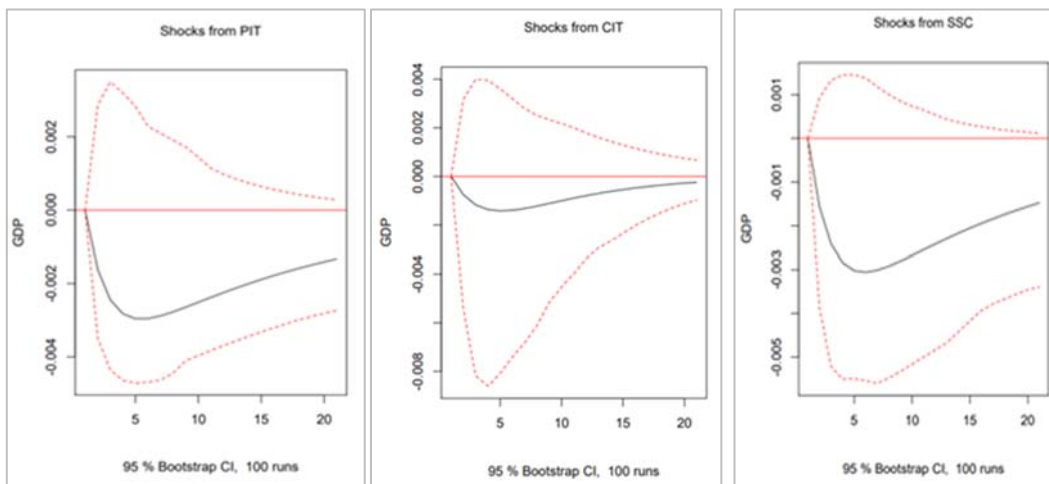
(2017), Ramey and Zubairy (2018). Afonso and Sousa (2012). A newly built up method for measuring the macroeconomic impact of tax changes is the narrative approach. This method is based on the legislative record to identify tax shocks and estimate their macroeconomic effects. This approach has been extensively used to estimate the impact of monetary policy in Romer and Romer (1989, 2004), government spending in Ramey and Shapiro (1998) and Ramey (2011) and for fiscal consolidations Guajardo et al. (2011). Romer and Romer, (2010) Also, Favero and Giavazzi, (2009), Favero and Giavazzi, (2010, 2012), Cloyne (2011). In Devries et al., (2011), Also, Perotti (2012 Favero and Giavazzi (2012), and Perotti (2012) thoughtfully discuss and compare the two approaches. For Narrative tax datasets see for Country-specific: Romer and Romer (2010), Cloyne (2013), Uhl (2013), Lopes (2015), Pereira and Wemans (2015), Gechert et al. (2016), Gil et al. (2018), Loate et al (2021). For Cross-country see Devries et al. (2011), Alesina et al. (2015, 2017), Gunter et al. (2019), David and Leigh (2018). For identification problem in narrative and VAR see Leeper (1997). Alesina, Favero and Giavazzi (2012) Guajardo et al., (2014) Furthermore, Mertens and Ravn (2013), Cloyne (2013). Guajardo et al., (2014) investigate the short-term effects of fiscal consolidation on economic activity in OECD economies by examining the contemporaneous historical narrative records. Moreover, Romer and Romer (2014), Mertens and Ravn (2014) Nughen et al (2016). Gunter et al (2017) Kato et al. (2018), Dabla-Norris and Lima (2018). Cloyne et al. (2018). Nguyen et al., (2020) Wan der Wielen (2020).

### 3. Tax Structure and Macroeconomic Framework, An Empirical Analysis

Regarding the data modeling, all the data are derived from OECD and The Conference Board Total Economy Database™, IMF and AMECO. At first, we focus on overall response of GDP growth from tax changes. So, we simply defined as a proxy for tax rate, total tax revenue as a percentage of GDP (TAX RATE) and employed it on annual real GDP growth. The same process we follow other tax aggregates such as Personal Income Tax (PIT), Corporate Income Tax (CIT), Property Tax (PT), Tax on Goods and Services (TOGS) and Social Security Contributions (SSC). The decomposition of tax revenue helps us to conclude regarding the impact of each different category of taxes in GDP growth. Another extension except for the decomposition of tax revenue is to analyze the macroeconomic impact of tax reforms in GDP aggregates and other macroeconomic determinants. Instead of looking at aggregate GDP, we now investigate the effects of the tax rate on unemployment (UNM), inflation (INF) as annual growth rates and other national accounts such as gross fixed capital formation (GFCF), general government consumption expenditure (GGCE) and household consumption (HSCONS) as percentage of GDP. As we have already mentioned we start with the simplest dynamic relationship that can capture the responses of GDP growth to changes in the total tax rate (revenue % GDP). Figure 1 shows the responses of GDP growth to an increase in the tax rate by 1% and more specifically falls at initial level by about a one percentage point, and then continues declining to a long-run decrease of approximately 0.2%. Thus, a positive shock to tax revenue by 1% has a negative effect on output by 0,2% on the long run. We also provide with VAR estimation results and diagnostics.

**Figure 1.** Impulse Response Functions GDP growth and TAX RATE

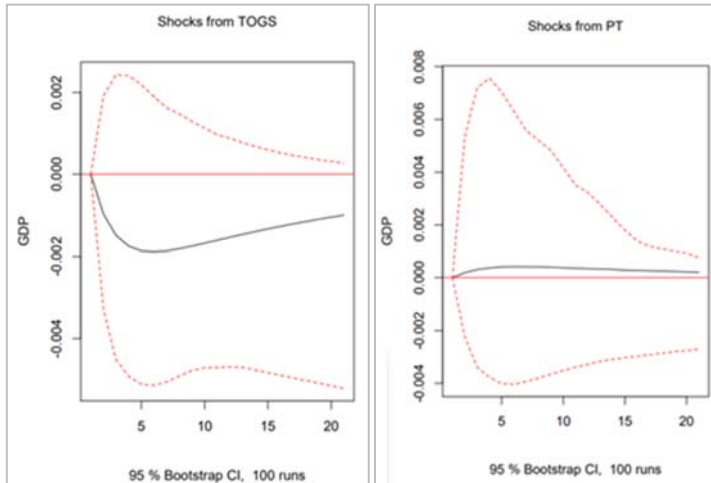
The first extension is the decomposition of tax revenues and their impact on GDP growth. It is obvious that positive effect on tax rates has negative effect on output. Concerning personal income taxes, we observe a long run decrease of 0,2% after a sharp decrease at first place while it seems that corporate income tax has smoother and clearer trend not affecting GDP growth to the extent that personal income tax does and become neutral to the long run.

**Figure 2.** Impulse Response Functions GDP growth and Income Tax and SSC

As it is clearly shown from Figure 2, Social Security Contributions has negative effect on GDP growth, with an initial decrease at 0,3% and a long run decrease of 0,2%. Furthermore, concerning other taxes positive effects on Tax on Goods and Services (TOGS) negatively affect long run decrease below of 0, 2% while positive effect on property taxes has neutral effect on GDP growth.

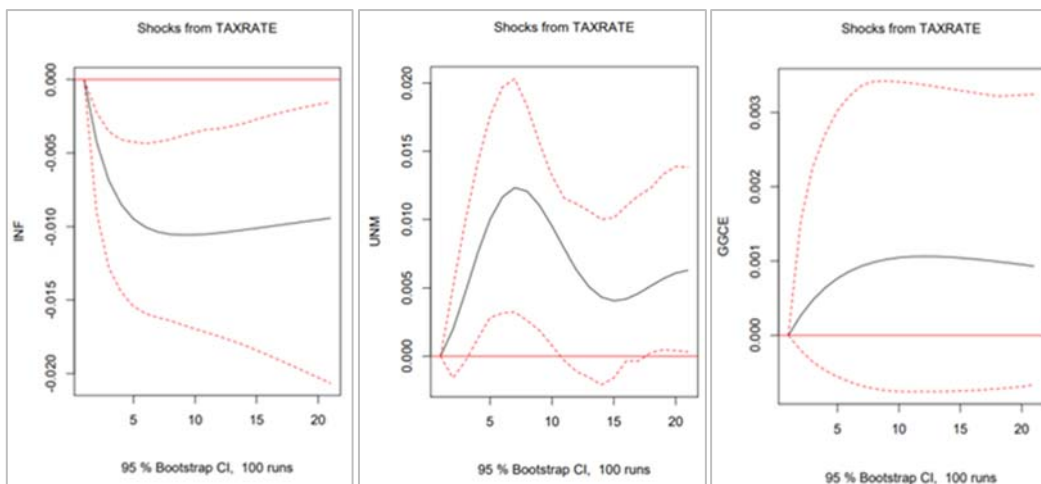


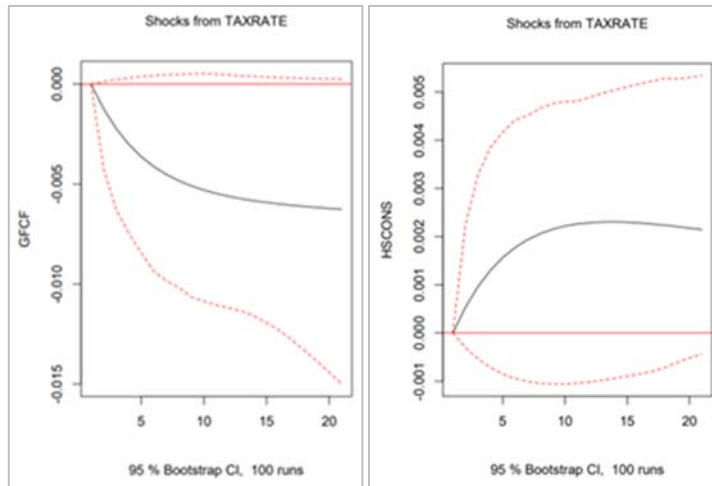
**Figure 3.** Impulse Response Functions GDP growth and Property Tax (PT) and Tax on Goods and Services (TOGS)



In this part we are going to analyze the macroeconomic impact of tax reforms in GDP aggregates. Instead of looking at aggregate GDP, we now investigate the effects of the tax rate on unemployment (UNM) which is negatively affect at first place and increase at 0,5% in the long run. As far inflation (INF) is concerned a negative response to positive tax shock is observed at 0, 1% on the long run. Gross fixed capital formation (GFCF) sharply decreased at 0,5% in the long run while general government consumption expenditure (GGCE) and household consumption (HSCONS) response positively to an increase from a tax shock at 0,1% and 0,2% respectively.

**Figure 4.** Impulse Response Functions GDP components and extensions and TAXRATE





### Fiscal Policy and Economic Growth (OLS Regression)

*Effects of fiscal policy on the economic growth in Greece 1974-2018*

Variable	Model 1	p-value	Model 2	p-value	Model 3	p-value	Model 4	p-value
constant	-0,060524	(0,3143)	0,102124	(0,0002)	0,068923	(0,0101)	0,042611	(0,0001)
Government Spending (% GDP)	-0,12913	(0,2261)	-0,198764	(0,0010)				
Tax Revenue (% GDP)	0,764877	(0,0042)			-0,190181	(0,0362)		
Debt (% GDP)	-0,093961	(0,0061)					-0,030466	(0,0020)
R-squared	0,371327		0,22496		0,098051		0,200878	
Adjusted R-squared	0,325327		0,206936		0,077075		0,182294	
Durbin-Watson	1,138521		0,808801		0,712215		0,789056	
F-statistic	8,07226		12,48101		4,674531		10,80904	
Prob (F- statistic)	0,000243		0,000996		0,03622		0,002018	
Obs	45		45		45		45	

*Taxation and Government Spending Greece 1974-2018*

*Taxation and Debt Greece 1974-2018*

Variable	Model 1	p-value	Variable	Model 1	p-value
constant	0,100138	(0,0091)	constant	1,515277	(0,0000)
Tax Revenue (% GDP)	1,191384	(0,0000)	Tax Revenue (% GDP)	8,527071	(0,0000)
R-squared	0,675763		R-squared	0,910817	
Adjusted R-squared	0,668223		Adjusted R-squared	0,908743	
Durbin-Watson	0,452527		Durbin-Watson	0,549237	
F-statistic	89,61907		F-statistic	439,1564	
Prob(F- statistic)	0		Prob(F- statistic)	0	
Obs	45		Obs	45	

Our empirical finding, as it is highlighted in the above table shows positive and strong relationship between taxation, government spending and debt while a fact is that taxation is less harmful to growth combined with government spending and debt. Moreover, taxation, government spending and debt have negatively relationship with growth. Our

analysis reveals that tax revenue and government spending are more harmful to growth than debt<sup>(1)</sup> and this can be explained that poor tax collection and increased government spending lead to high level of debt and thus policies should focus on preventive rationalization measures. In this context policy makers should adopt a strategy that limit government spending increase debt sustainability and maintain revenue capacity to a level not harmful to growth.

#### 4. Conclusions

To sum up we conduct a further analysis by applying regression between tax revenues by type of tax and GDP growth. At first, we conclude, aligned with previous empirical studies, that total tax revenues, personal income taxes, tax on goods and services and social security contributions have negative impact on GDP growth. Also, looking on their p-values, there is a statistically significance and negative relationship which also is complied with relevant literature. More specifically, results show that 1% increase in total tax revenue decrease GDP growth for 0,19%, a 1% increase in personal income taxes have negative impact of 1,09%, a 1% raise on social security contribution revenues have negative impact of 0,56% and tax on goods and services by 0,67%. On the other hand, our analysis reveals that despite the fact that corporate and property taxes have positive and negative impact on GDP growth respectively, they have no statistically meaningful impact on growth in terms of statistical significance. The latter may be attributed to further investigation by examining specific tax bases characteristics, structure of the economy, and poor revenue evolution per GDP. Thus, using VAR models and impulse response functions we focus on the effect of tax rate on real GDP growth not only at overall level but also per type of tax. In addition, we examine the effects on tax revenue on unemployment, inflation and other national accounts such as gross fixed capital formation, general government consumption expenditure and household consumption. More specifically, GDP growth falls to an 1% increase in the tax rate by about a one percentage point at first place, and then continues declining to a long-run decrease of approximately 0.2%. Thus, a positive shock to tax revenue has a negative effect on output. The first extension that we made is the decomposition of tax revenues and their impact on GDP growth. It is obvious from our analysis that positive effect on tax rates has negative effect on output. Concerning personal income taxes, we observe a long run decrease of 0,2% after a sharp decrease at first place while it seems that corporate income tax has smoother and clearer trend not affecting growth to the extent that personal income tax does. Also, social security contributions have negative effect on growth, with an initial decrease at 0, 3% and a long run decrease of 0, 2%. Concerning other taxes, tax on goods and services negatively affect long run growth with decrease below of 0,2% while property taxes has neutral effect on GDP growth. Another contribution is the fact that we analyze the macroeconomic impact of tax reforms on GDP aggregates and other macroeconomic determinants. Instead of looking at aggregate GDP, we investigate the effects of the tax rate on unemployment which is negatively affect at 0, 5% in the long run. As far inflation is concerned a negative response to positive tax shock is observed at 0, 1% on the long run. Gross fixed capital formation sharply decreased and followed 0,5% in the long run while general government consumption expenditure and household consumption response

positively to an increase from a tax shock at 0,1% and 0,2% respectively. Having in mind, the crucial role of government spending and debt sustainability we apply a general model that enables us to estimate the impacts of the fiscal policy on economic growth. Thus, the equations consist of annual growth rate of GDP, government spending, total tax revenue and gross debt. Our empirical findings show positive and strong relationship between taxation government spending and debt while a fact is that taxation is less harmful to growth compared with other two variables, government spending and debt respectively. In this context policy makers should adopt a strategy that promote rationalization of government spending and debt sustainability and maintain revenue capacity to a level not harmful to long growth. Thus, the empirical part is vital to analyze and appraise the robustness of tax methodology in a purposeful way, highlight key recommendations for policymakers and tax authority to contribute further to strategic planning, revenue capacity, sustainability of public finance and efficient tax administration in Greece. Overall, the evaluation of the tax changes impact in Greece economy will be examined under the scope of macroeconomic performance and this plays a crucial role in the application of efficient strategies from tax authorities.

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#### Note

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<sup>(1)</sup> Coefficient at 0,19 compared to 0,03.

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## Consumerism and capitalism: dynamic evolution, economic benefits, and ethical challenges

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**Abstract.** *Consumerism and capitalism have played pivotal roles in shaping modern economies, driving industrialization, economic growth, and technological innovation. This paper examines the historical evolution of consumerism, from ancient trade economies to the industrial revolution and the rise of global consumer markets. It explores the symbiotic relationship between capitalism and consumer culture, highlighting both economic benefits – such as job creation, increased productivity, and social mobility – and ethical challenges, including environmental degradation, wage stagnation, and exploitative labour practices. The paper also discusses contemporary shifts in consumer behaviour, emphasizing ethical consumption, sustainability, and corporate responsibility. Ultimately, it argues for a balanced approach that preserves the economic advantages of consumerism while addressing its socio-environmental costs.*

**Keywords:** capitalism, economic growth, technological evolution, globalization, consumerism.

**JEL Classification:** D12, E21, O33.

## 1. Introduction

Consumerism, widely defined as the societal and economic framework in which the purchase of goods and services is prioritized and praised, is a phenomenon that is firmly rooted in today's capitalist world. While consumerism is most linked with twentieth-century industrial capitalism, its origins can be traced back to earlier periods in human history.

The ancient world's early trade-based economy laid the groundwork for consumerism. Luxury commodities became emblems of wealth and power among elites in societies like Mesopotamia, Egypt, and later Greece and Rome (Sassatelli, 2007). Spices, silk, and gold were often bought through long-distance trade, resulting in early consumer markets. Still, such consumption was confined to the elite, as most people lived on necessities.

During the medieval period in Europe, consumer behaviour was more restricted driven by feudal structures and the Church's moral teachings, which emphasized modesty and the spiritual perils of material excess (Campbell, 1987). However, the Renaissance brought about a cultural revolution, especially among the urban mercantile classes, as art, fashion, and literature celebrated individual expression and material acquisition. These changes paved the way for a more widespread cultural acceptance of consumerism.

The Industrial Revolution of the 18th and 19th centuries was instrumental in turning consumerism from an elite to a mass-market phenomenon. Mechanized production and technical innovation significantly reduced the cost of goods, making them attainable to a wider audience. For example, improvements in textile manufacturing permitted mass production of affordable apparel in the late 18th century, resulting in the first "consumer goods revolution" (McKendrick et al., 1982).

The rise of a capitalist market economy accentuated this trend. Consumerism became a symbol of social mobility and identity as cities expanded and the middle class grew. Department stores became temples of consumerism, providing not only goods but also a sensory experience that created aspirational purchasing (Miller, 1998).

Consumerism peaked during the twentieth century, particularly in Western cultures. Following World War II, economic prosperity and technological advances resulted in extraordinary levels of disposable income and leisure time. Governments, particularly in the United States, have emphasized consumer spending as a crucial driver of economic growth. The rise of mass media, particularly television, was essential in promoting consumer desires, with advertising creating societal ideals surrounding consumption (Ewen 1976).

The 20th century also saw the globalization of consumerism. Advances in transportation and communication have allowed multinational corporations to expand and grow their markets, bringing consumer goods to previously unreachable and inaccessible territories. Consumerism also became a cultural export, as Western-style malls, brands, and media began to influence lifestyle across the world (Ritzer, 1999).

From an economic standpoint, consumerism has been both beneficial and detrimental. On the bright side, it has been a big contributor to economic growth. High levels of consumer

spending increase demand, drive production, and create jobs. For example, the postwar economic boom in the United States in the 1950s was largely driven by a consumer-driven economy, as evidenced by the expansion of businesses such as automobiles, electronics, and household appliances (Galbraith, 1958).

Still, the reliance on consumer spending exposes economies to downturns. For example, the 2008 global financial crisis was caused in part by excessive consumer debt and easy credit. Additionally, consumerism often contributes to economic inequality, since those with higher salaries can afford services and goods that lower-income groups cannot.

Consumerism has had a significant impact on modern society, shaping cultural ideals, social conduct, and even individual identities. One of its most notable effects is the commodification of social status. In consumer societies, material items often serve as indicators of success, causing people to associate personal value with purchasing power (Baudrillard, 1998).

On a wider cultural level, consumerism has resulted in the standardization of lifestyle, as worldwide companies and media promote standardized ideals for beauty, wealth, and happiness. This has provoked criticism of cultural imperialism, particularly in areas where consumerist ideals have displaced traditional values and practices (Tomlinson, 1999).

The environmental effects of consumerism are likely its most important problem. High levels of consumption contribute to resource depletion, pollution, and greenhouse gas emissions. For example, the fast fashion sector, a symbol of modern consumerism, is one of the world's major polluters, contributing to water waste and microplastic pollution (Fletcher, 2014).

Consumerism creates ethical concerns related to labour standards, as the demand for low-cost items frequently leads to exploitation in global supply chains. Efforts to address these challenges, such as the growth of ethical consumerism and sustainability movements, demonstrate an increasing understanding of the importance of responsible consumption.

## 2. Capitalist empowered consumerism

Capitalism created the ideal environment for consumerism to grow and flourish. At its heart, capitalism is based on private ownership of the means of production and market-driven economies, with profit as the primary motive. Consumerism adds to this system by producing constant demand for goods and services, thereby ensuring that production remains profitable.

The origins of capitalism can be traced back to the late medieval period in Europe. Feudal economies, which were primarily agrarian and subsistence-based, began to shift to market-oriented structures as commerce and urbanization increased in the 12th and 13th centuries (Braudel, 1982). The rise of merchant guilds and the spread of long-distance trade routes promoted the emergence of a money economy, which replaced barter systems.

The Renaissance (14th–17th centuries) was a watershed moment in the growth of capitalism. During this period, the rediscovery of classical knowledge and the growth of

humanism encouraged individual enterprise and inventiveness. Cities like Florence and Venice were banking and commerce hubs, promoting the development of financial institutions including banks, joint-stock companies, and credit systems (Arrighi, 2010). The Medici family of Florence, for example, played a critical role in early capitalist banking systems.

The 16th and 17th centuries saw the rise of early capitalist systems, fuelled by trade and colonization. The Age of Exploration enabled European nations to create colonial empires in Asia, Africa, and the Americas, resulting in broad networks of trade. The flood of precious metals from the New World, notably silver, drove economic expansion and inflation, resulting in the "Price Revolution" (Pomeranz, 2000).

Mercantilism, the main economic theory of the time, emphasized state control over trade to increase wealth and power. While not entirely capitalist, mercantilism paved the way for capitalism by encouraging market expansion and international competition (Smith, 1776). The formation of chartered trading firms, such as the British East India Company and the Dutch East India Company, reinforced capitalist practices.

The Industrial Revolution of the 18th and 19th centuries constituted an important turning point in the capitalist age. Technological innovations such as the steam engine and automated textile manufacture shifted economies from agrarian to industrial (Landes, 1969). This transition coincided with the growth of factory systems, which concentrated labor and capital in urban areas.

During this time, some key aspects of modern capitalism emerged. Mechanized production improved productivity and reduced prices, allowing for mass production of commodities. An expanding urban workforce became wage-dependent, signalling a transition away from agrarian self-sufficiency. The concentration of wealth in the hands of industrialists and entrepreneurs boosted investment and innovation (Marx, 1867).

Adam Smith's foundational work, *The Wealth of Nations* (1776), outlined the foundations of free-market capitalism, emphasizing the importance of competition, self-interest, and minimal government involvement in promoting economic prosperity.

The 19th century saw the global growth of capitalism, fuelled by industrialization and imperialism. European nations expanded their capitalist economies through colonial conquests, exploiting resources and labour in colonized territories (Bodislav, 2011). This century also saw the emergence of financial capitalism, with stock markets, investment banks, and multinational companies becoming increasingly important (Hilferding, 1910).

In the twentieth century, capitalism evolved to meet new challenges as well as possibilities. The Great Depression of the 1930s showed the flaws in *laissez-faire* capitalism, resulting in an emergence of Keynesian economics, which pushed for government intervention to stabilize markets and promote social welfare. Following World War II, the Bretton Woods system created a framework for global capitalism, with institutions such as the International Monetary Fund (IMF) and the World Bank promoting and supporting international trade and economic development.

Globalization shaped the late twentieth and early twenty-first centuries, as capitalist economies grew integrated through trade, finance, and technology. Advances in communication and transportation supported worldwide market integration, while the growth of multinational firms resulted in complex supply chains spanning continents.

In the 1980s, politicians such as Ronald Reagan and Margaret Thatcher promoted free-market policies that minimized government regulation and privatized state-owned enterprises (Friedman, 1962).

The rise of technology corporations and the digital economy has altered capitalism, with companies such as Amazon, Apple, and Google exemplifying the concentration of wealth and influence in the tech industry.

The growing dominance of financial markets over productive industries has resulted in new opportunities and risks, as evidenced by the 2008 global financial crisis.

Capitalism has had profoundly and diverse impacts on society and the economy, influencing modern life in both positive and negative ways. Capitalism promotes innovation by rewarding entrepreneurs and businesses that create new technology and goods. Market competition encourages efficient resource allocation and production.

Capitalist economies have created unprecedented wealth, boosting living standards and lowering poverty in many areas (Pomeranz, 2000). Critics claim that capitalism positions earnings over people, resulting in labour exploitation and poor working conditions (Marx, 1867). Capitalist systems' quest of expansion and consumerism has contributed to climate change, deforestation, and resource depletion (Foster, 2000).

A fall in consumerism would have a large influence on GDP in economies where consuming accounts for most of the economic activity. For example, in the United States, consumer expenditure accounts for over 70% of GDP. A sudden drop in expenditure without a planned transition could result in economic collapse, job losses, and disruption in society (Galbraith, 1958). Careful policy planning, including investments in green jobs and social safety nets, would be required to reduce these risks.

Consumerism and capitalism, regardless of their drawbacks, have undoubtedly contributed to human progress. They have promoted innovation, enhanced global connectivity, and raised many people's living standards. However, there are major trade-offs to these gains.

The profit incentive has pushed advances in medicine, technology, and infrastructure. From vaccinations to cell phones, economic rivalry often stimulates speedy invention. Critics claim that this innovation is usually mismatched with societal demands, focusing on profit-generating advances rather than universally beneficial ones (Foster, 2000).

Capitalist economies have lifted millions of individuals out of poverty, especially in emerging markets such as China and India. Globalization of trade and manufacturing has led to unparalleled wealth growth (Pomeranz, 2000).

The ecological impact of consumption is enormous, contributing to climate change, deforestation, and biodiversity loss.

### 3. Modern societies and the healthy need to consume

The mindset of purchasing something to achieve happiness has its origins in the economic and cultural transformations that began with the Industrial Revolution and expanded throughout the twentieth century. While consumerism is not a new concept—humans have always traded and purchased goods—the connection of consumption to emotional fulfilment and identity is a relatively recent and modern phenomenon.

The Industrial Revolution (18th-19th centuries) represented the first significant shift toward a society based on work and consumption. Prior to this period, most individuals lived an agrarian lifestyle, producing only what they needed to survive and consuming sparingly. Nevertheless, industrialization created and introduced mass production, which significantly increased the availability of goods while decreasing their cost (Hobsbawm, 1962). Factories needed many workers, and the wages from these jobs formed a new class of people able to afford manufactured goods.

In the early twentieth century, consumerism evolved as a cultural force. Industrialists such as Henry Ford revolutionized manufacturing by introducing assembly-line production, making products like automobiles affordable to the average worker. Ford famously stated that he wanted his employees to be earning enough money to buy the products they produced, reflecting the emerging symbiosis between production and consumption (Galbraith, 1958).

As previously mentioned, consumerism has historically been instrumental in the improvement of living standards, technological advancements, and economic expansion. Nevertheless, ethical concerns regarding the ethical implications of global markets began to emerge as they developed. Over time, consumerism evolved from a force of progress to a system that was criticized for the propagation of environmental exploitation. In a similar direction, contemporary societies must deal with an increasing affordability crisis, as individuals are unable to preserve their purchasing power. This change raises critical issues regarding the origin of affordability challenges, which may be attributed to a cultural shift in financial motivation and work ethic or to the increasing costs of goods and services.

The emergence of planned obsolescence, a phenomenon in which products are intentionally designed with short lifespans to encourage repetitive purchases, has become a significant ethical issue. In the late 20th century, critics stated that consumerism had transformed into a system that prioritized corporate profits over sustainability and ethical responsibility, and that it was wasteful and manipulative (Packard, 1960).

In the early 2000s, the ethical decline of consumerism was further accelerated by the increase of rapid fashion, environmentally destructive production methods, and exploitative labour practices (Klein, 2000). Global supply chains generated substantial carbon emissions, while multinational corporations outsourced manufacturing to countries with weaker labour protections, resulting in worker exploitation in sweatshops.

*For what reason are individuals having trouble affording essential goods and services?*

Although consumerism initially supported greater affordability through mass production and economies of scale, present-day economic trends have reversed this effect, making



essential goods and services increasingly inaccessible. This transition is the result of a variety of interconnected factors:

- **Wage stagnation and inflation.** One of the most significant factors contributing to decreased affordability is inflation, which affects the purchasing power of money. In numerous countries, wages have failed to keep pace with the increasing cost of living, particularly in the areas of housing, healthcare, and education, over the past few decades (IMF, 2023). In contrast to previous generations, who were able to afford homes, vehicles, and other assets due to stable employment, the current workforce is confronted with higher living costs without proportional salary increases, resulting in financial strain (Piketty, 2014).
- **Market Consolidation and Corporate Pricing Strategies.** In numerous industries, large corporations possess pricing power, which enables them to establish exorbitant prices without concern for competition. This has been especially evident in the housing market, where corporate investment in real estate has resulted in a rise in property values and rental costs, leaving homeownership increasingly unattainable for younger generations (Milanovic, 2016). Similarly, industries such as pharmaceuticals, higher education, and even fundamental consumer goods have experienced price increases that exceed income growth, which has intensified financial hardships for ordinary consumers (Stiglitz, 2019).
- **Cultural shifts, social media, and changing work ethics.** Cultural changes, notably in attitudes toward work and financial ambition, have contributed to the affordability crisis in addition to economic factors. In recent years, the "bare minimum" work mentality, which has been promoted on social media, has impacted an increasing segment of the population, resulting in a disengagement from high-performance work culture (Newport, 2016). This change is partially a response to the increasing recognition that traditional employment structures no longer offer the same level of financial security as they once did, as well as to the culture of burnout.

Although it is crucial to promote work-life balance, the current trend of dismissing ambition and competitiveness entirely raises concerns regarding long-term economic mobility. When there is a decrease in the number of individuals who are willing to pursue specialized professions, entrepreneurship, or career advancement, the overall productivity decreases, which in turn restricts income growth and contributes to growing economic inequality (Bregman, 2017). This trend has resulted in a paradoxical situation in which individuals are less inclined to take the necessary measures to improve their financial situation, despite feeling dissatisfied with it.

Consumerism's change from an economic force to an ethical issue mirrors larger economic, environmental, and cultural shifts. Economic dissatisfaction has been accentuated by cultural shifts in work ethic and financial motivation, in addition to the increasing costs and corporate pricing strategies that have rendered essential products less affordable. Society must achieve a balance between fair economic policies that protect purchasing power and individual accountability in financial decision-making to address these challenges. While protecting the advantages that consumerism has historically offered, the restoration of economic equilibrium can be achieved by promoting ethical consumerism, cultivating a productive work environment, and guaranteeing fair market competition.

#### 4. The economic benefits of consumerism: global & historical analysis

The continuous acquisition of products and services, which is referred to as consumerism, has long been a driving force in the development of the global economy. Despite criticism for encouraging materialism and environmental concerns, consumerism has been a key factor in boosting employment, economic expansion, and technical advancement. Historically, the rise of consumer-driven marketplaces resulted in substantial economic transformations, and consumer spending remains a critical foundation of economic stability today. In this article, the economic benefits of consumerism are examined from both historical and contemporary global perspectives, with a particular emphasis on its ability to increase industrial production, boost competition, and stimulate economic growth.

##### *Consumerism's historical financial advantages*

Early 20th-century industrialization, mass production, and the expansion of consumer credit all contributed to the emergence of consumerism. The 1920s witnessed a dramatic change in economic systems in both the US and Europe as customers had easier access to fashion items, home appliances, and cars. Economic expansion was further reinforced by this spike in demand, which promoted large-scale manufacturing and created jobs (Lebergott, 1993). The cost of commodities was significantly reduced by mass production, as demonstrated by Henry Ford's automobile assembly lines. This made consumer products more accessible to the general population and improved overall living standards (Galbraith, 1958).

In Western Europe and Japan, consumerism was notably influential in the reconstruction of war-torn economies following World War II. High levels of consumer spending during the postwar economic boom, commonly referred to as the "Golden Age of Capitalism," fueled quick industrial growth and job creation (Marglin, Schor, 1990). Countries like Japan and West Germany implemented consumer-driven economic policies that prioritized the production of products for both domestic and international markets, resulting in unprecedented economic growth. Consumer lifestyles were revolutionized by the increasing availability and number of durable products, including automobiles and household appliances, which established robust industrial supply chains that facilitated and supported economic expansion (Cross, 2000).

Additionally, the economic development of emergent markets was facilitated by the globalization of consumerism in the late 20th century. Developing nations, including China and India, experienced substantial industrial expansion as Western consumer culture expanded globally (Stiglitz, 2002). This expansion was facilitated by an increase in domestic consumption and foreign investment. These nations were able to attain rapid urbanization, enhanced living standards, and elevated economic mobility because of the transition from subsistence economies to consumer-oriented markets.

##### *Consumerism's economic advantages and rewards in the present day*

In today's global economy, consumerism continues to be a significant factor in the acceleration of economic development. In developed countries, personal consumption expenditures account for a substantial portion of GDP, with consumer spending accounting

for nearly 68% of the U.S. economy and similarly large percentages in the European Union (Krugman, Wells, 2018). This trend is also prominent in emerging economies, where the expansion of the middle class has resulted in a heightened demand for consumer products and services.

The role of consumerism in generating employment is one of its most significant economic benefits. A substantial workforce is required in a variety of sectors, such as manufacturing, retail, logistics, and service industries, due to the substantial demand for products and services (Ritzer, 2019). The retail and e-commerce sectors have experienced rapid expansion, resulting in an abundance of employment opportunities on a global scale. For instance, the emergence of multinational retail corporations like Alibaba and Amazon has generated millions of employment opportunities, both directly in logistics and distribution and indirectly in technology and customer service (Kalleberg, 2011).

Innovation and competition among businesses are also driven by consumerism. Companies are perpetually aspiring to enhance and improve their existing products and introduce new ones to attract and retain consumers. The digital economy and green technology are among the new industries that have emerged because of the competitive environment that promotes technological advancements (Schumpeter, 1942). For instance, the automotive sector has experienced substantial improvements in energy efficiency and environmental sustainability because of the increasing demand for sustainable consumer choices (Christensen, 1997).

Also, consumerism provides economic diversification by promoting a diverse array of products and services that are customized to meet the unique requirements of consumers. Businesses are encouraged to accommodate a wide range of cultural preferences and lifestyle trends as global markets expand, which promotes a more dynamic and interconnected global economy (Brookings Institution, 2019). This diversification has been beneficial to the fashion, food, and entertainment sectors, as consumers are increasingly seeking personalized products that align with their social values and personal identities.

In both historical and contemporary contexts, consumerism has been a critical factor and an essential component in the advancement of economic development, the improvement of living standards, and the encouraging of innovation on a global scale. Consumer-driven markets have consistently generated employment, empowered competition, and expanded economic opportunities, from the industrial transformations of the early 20th century to the modern globalized economy. Although concerns regarding sustainability and ethical consumption persist, the economic benefits of consumerism—including the promotion of innovation, increased GDP, and job creation—have made a substantial contribution to the prosperity of contemporary economies. It will be essential to maintain long-term economic stability by balancing consumer-driven economic development with sustainable practices as the world keeps advancing and evolving.

## 5. Improving the quality of life through technological evolution

Accelerating technological innovation is one of the most significant ways in which consumerism has advanced the world. Businesses are encouraged to allocate resources toward research and development initiatives as consumers demand more sustainable, efficient, and superior products. This competition has resulted in significant improvements to living standards by developing advancements in industries such as transportation, healthcare, and communication. For instance, the demand for smartphones, artificial intelligence, and renewable energy solutions has resulted in rapid advancements that are beneficial to both individuals and industries (Christensen, 1997). The global transition to smart technology and automation, which is primarily motivated by consumer preferences, has improved productivity, safety, and convenience in a variety of industries (MasterClass, 2023).

In addition, the accessibility of essential products and services has been provided by consumerism. As a result of consumer demand, mass production has reduced the cost of commonplace necessities, rendering them more accessible to a broader population. The global health outcomes have been substantially improved by the increased availability of healthcare technology, pharmaceuticals, and nutrition-focused products (Stiglitz, 2002). Consumerism has raised the standard of living by promoting economies of scale. This is especially true in emerging economies where rapid urbanization has made it easier to access modern conveniences (Brookings Institution, 2019).

### *The new era of corporate responsibility and ethical consumerism*

In recent decades, consumerism has undergone a transformation that embraces ethical and sustainable consumption, which is suggestive of the increasing global consciousness of environmental and social concerns. Businesses are being prompted to implement more responsible practices as consumers are increasingly prioritizing products that are consistent with their values. This change has resulted in the growth of corporate social responsibility initiatives, eco-friendly production, and equitable trade. The power of consumer-driven change has been demonstrated by companies that prioritize ethical sourcing, sustainable packaging, and reduced carbon footprints, which have acquired competitive advantages (Kalleberg, 2011).

The advancement of environmental sustainability and labour rights has also been promoted by ethical consumerism. Responsible sourcing and transparent supply chains are implemented by brands to minimize negative environmental impacts and combat exploitative labour practices. Investopedia (2023) has found that consumers are more inclined to endorse businesses that prioritize eco-conscious manufacturing, safe working conditions, and equitable wages. This trend has had an impact on industries such as technology, food, and fashion, where sustainable alternatives are becoming increasingly popular.

### *Social progress and consumerism*

In addition to its economic influence, consumerism has been instrumental in advancing social progress by increasing accessibility to information and education. Educational

resources have become widely accessible because of the demand for digital technology and online services, which has enabled individuals to acquire knowledge and skills that were previously unreachable or limited. Platforms providing free and low-cost educational content are growing as customer engagement has expanded, opening new opportunities for learning and professional development around the world (Brookings Institution, 2019).

Global demand has driven media consumption, which has resulted in a more comprehensive representation of diverse cultures, identities, and perspectives. Streaming services, literature, and digital platforms have allowed for a greater degree of cultural exchange, thereby promoting inclusivity as well as understanding (Ritzer, 2019). The capacity to access a wide range of content has expanded societal awareness, thereby challenged conventional narratives and enabled progressive social change (Georgescu, 2023).

Although consumerism is often criticized for its detrimental effects, it has been an engine for positive improvements worldwide. In addition to its fundamental economic contributions, it has been instrumental in the advancement of technology, the enhancement of accessibility to products and services, advancing the adoption of ethical business practices, and the development of social progress. The transition to responsible and informed consumerism has illustrated that individuals possess the capacity to influence industries and cultivate sustainable growth. Businesses and governments must maintain a balance between economic expansion and ethical considerations to guarantee that consumerism continues to be a driving force for long-term global progress, as consumer demand continues to evolve.

## 6. Consumerism, Motivation, and the Psychological Effects of Anti-Materialistic Narratives

Although consumerism has been an engine for economic advancement, innovation, and an enhanced quality of life, its social perception has become increasingly complicated. In certain social and cultural contexts, individuals who pursue success and material rewards are subjected to criticism, which creates an environment that discourages ambition and competition. As a result of this change in attitudes, individuals may experience a decrease in motivation and determination, as they believe that the efforts they make to better their financial status or acquire consumer products are being criticized and attacked. This perspective can have long-term implications for both personal development and economic growth due to its psychological and societal consequences.

### *The social stigma associated with success and consumerism*

In numerous societies, an increasing ideological divide has emerged between those who build material success as a symbol of achievement and those who regard consumerism as excessive, wasteful, or morally questionable. The direct demonization of financial success and ambition will create an environment in which individuals are unmotivated to pursue and aim for excellence.

As shown by psychological research, human behaviour is significantly influenced by intrinsic and extrinsic motivation. Personal fulfilment is the driving force behind intrinsic motivation, while extrinsic motivation is characterized by external rewards, including

affluence, recognition, or material possessions (Deci, Ryan, 2000). Extrinsic motivation may be diminished because of societal judgment, which may discourage individuals from achieving financial success or material rewards, resulting in a decrease in performance, effort, and innovation (Dweck, 2006).

In economic and psychological studies, rewards are a primary motivator of human effort. Individuals might question the purpose of working harder or excelling in their field when financial rewards, status symbols, and material aspirations are criticized or devalued. The motivation to pursue high-paying careers, establish businesses, or innovate in competitive industries will be diminished and compromised if ambition is associated with greed or moral failure (Pink, 2009).

Moreover, broader economic stagnation can be worsened by social environments that discourage ambition and competitiveness. A culture that penalizes success rather than honours effort may result in a decrease in productivity, diminished risk-taking, and reduced advancements in industries that depend on high-performance individuals (Heath, Sitkin, 2001). Economic dynamism and progress are prominent in societies that prioritize ambition and competition, including those that value entrepreneurship and reward dedication and perseverance (Schumpeter, 1942).

*The psychological consequences of being criticized for aspiration, ambition and purpose*

Along with the detrimental impact on the economy, the social judgment connected to wanting to be prosperous and being successful can lead to depression, anxiety, and a lack of personal fulfilment. Individuals who want to be successful and financially independent may feel a sense of disconnect and dissatisfaction when their wants and needs clash with what a few groups of people thinks of them. This tension can lead to feelings of guilt, self-doubt, and diminished self-esteem, particularly when individuals are forced and face pressure to minimize and limit their aspirations to accommodate social norms (Festinger, 1957).

Research in the field of psychology indicates that self-determination and goal-setting are crucial and essential for maintaining mental health. People may experience a decrease in their sense of purpose and fulfilment when they are discouraged from pursuing material rewards that are consistent with their values or feel that they lack control over their aspirations (Sheldon, Elliot, 1999). Moreover, the absence of motivation to pursue personal or financial growth can result in heightened feelings of apathy, dissatisfaction, and disengagement from work and social life (Seligman, 2002).

Consumerism has always been a source of drive, pushing people to put their skills to use and come up with innovative and creative concepts that would help societies develop and evolve (Georgescu, 2020). Nevertheless, the increasing social stigma associated with financial success and ambition has resulted in a decrease in motivation, which has led to disengagement and a decrease in effort across a variety of areas. It is essential to establish a culture that maintains a balance between ethical responsibility and ambition to guarantee ongoing economic growth and personal fulfilment. Societies should cultivate environments that celebrate success in partnership with values such as sustainability and social contribution, rather than discouraging financial aspirations (Bodislav, Georgescu, 2023).

## 7. Conclusion

It is imperative to maintain a healthy, sustainable, and productive approach to financial motivation by balancing ambition with ethical consumerism. When individuals are motivated to pursue success and financial growth while also considering the broader implications of their consumption decisions, they are more likely to experience long-term fulfilment, economic stability, and psychological well-being. This approach confirms that ambition is perceived as a positive force rather than as vanity or greed.

Innovation, progress, and self-improvement are all powered by the fundamental human drive of ambition. Individuals strive for excellence in their professions, education, and business activities in societies that encourage ambition. This results in increased productivity, creating employment opportunities, and economic dynamism (Schumpeter, 1942). Nevertheless, the demotivation of individuals may result in economic stagnation and reduced innovation when ambition is discouraged or condemned (Dweck, 2006).

A culture that prioritizes ambition encourages:

- Entrepreneurship, competent labour, and competitive markets contribute to increased economic output.
- Elevated quality of life, as individuals aspire for personal and professional success.
- Increased advancement in society, which enables individuals to boost their financial status through education and dedication (Frankl, 1959).

Ethical consumerism guarantees that personal success and achievement does not compromise sustainability, social justice, or long-term well-being. Ethical consumerism implies mindful purchasing decisions that consider factors such as environmental sustainability, adequate labour practices, and responsible corporate behaviour (Goleman, 2009).

While maintaining an awareness of their influence on society and the environment, individuals are motivated to achieve success.

A culture that inspires ethical consumerism and encourages ambition must establish a balance between personal well-being, social responsibility, and financial success. Individuals can continue to pursue financial motivation without participating to negative social or environmental impacts by establishing a society that prioritizes innovation, dedication, and ethical decision-making. This approach can guarantee that consumerism is a constructive force, supporting sustainable development and economic growth, thus helping to create a more prosperous and beneficial future.

### *Consequences of the elimination of consumerism*

Completely eliminating consumerism would result in severe adverse consequences, including the disruption of economies, the reduction of employment, stagnation of technological advancements, and a decline of the overall quality of life, as following:

1. Economic Collapse and Job Loss. The complete elimination of consumerism would result in a severe contraction of economies worldwide, which would result in widespread job losses and financial instability. The absence of consumer spending

would lead to a decrease in industrial production, business closures, and diminished investments, as it is a significant component of economic activity (Piketty, 2014).

Consumer demand is a significant factor in the retail, entertainment, technology, and hospitality sectors, which would be particularly impacted. This would result in a rise in poverty rates, reduced social mobility, and economic stagnation, as millions of workers in these sectors would be unemployed (Stiglitz, 2019).

2. **Decline in Innovation and Advancement.** A world without consumerism would lack the competitive drive that stimulates invention. Industries would have minimal motivation to allocate resources to research and development if consumer demand did not motivate them to create new technologies and enhance existing products (Schumpeter, 1942). Revolutionary products, such as smartphones, modern medicine, and transportation advancements, have been historically driven by consumer needs (Christensen, 1997). The elimination of consumerism would hold back technological advancement, thereby inhibiting economic and scientific progress.
3. **Decline in Quality of Life.** The loss of consumerism would not only affect economies but also lead to a decrease in the overall quality of life. The availability of a wide range of products and services helped improve the well-being of individuals, increased convenience, and provided them with more options. Access to contemporary healthcare, entertainment, personal technology, and transportation would be severely limited in the absence of a robust consumer market (McDonough, Braungart, 2002). Additionally, the elimination of consumerism could result in a more restricted and controlled economic system, in which governments or a limited number of organizations determine the distribution of resources. This could potentially restrict financial independence, limit entrepreneurship, and reduce individual freedoms (Galbraith, 1958).

Despite the challenges that it faces, consumerism continues to be a critical component of global economic stability, innovation, and optimized living standards. It promotes technological advancements that benefit individuals and societies, supports job development, and drives economic growth. Although ethical consumerism and sustainable practices are necessary to address concerns about overconsumption and environmental impact, the complete eradication of consumerism would result in economic destruction, a loss of innovation, and a decrease in quality of life. Rather than entirely opposing consumerism, a more balanced approach that prioritizes corporate accountability, sustainability, and responsible consumption can guarantee ongoing advancement without excessive waste and exploitation.

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## Business cycle synchronization of Tunisia and Euro Zone countries: a parametric and non-parametric analysis

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**Abstract.** *In this article, we used a parametric Hamilton approach and a non-parametric Bry-Boschan method to characterize the business cycles of Tunisia and the Euro zone between 1990 and 2017. The estimation results show that Tunisia's growth cycle is very close to that identified for the Euro zone. Furthermore, based on the transition probability matrix, we find that these coefficients are highly significant and differentiated, ranging from 0.739 to 0.989. Consequently, these probabilities illustrate the state of the Tunisian economy, which is characterized by major recessions. As for the Euro zone economy, the smoothed and filtered probabilities identify five major recessions.*

**Keywords:** business cycle, Markov Switching Model, Bry-Boschan method, Tunisia, Euro zone.

**JEL Classification:** E32, F43, F47, C32.

## 1. Introduction

Although the subject of business cycles has been observed by economists since the 19th century. With the great depression of 1929, the study of cyclical phenomena was inspired by the credit theory initiated by Hayek (1933) and Von Mises (1933). However, after the Second World War, many theories coexisted in the analysis of business cycles. In this respect, pre-Keynesian analyses based on the work of (Wicksell, 1898; Frisch, 1933 and Slutsky, 1937) considered that cyclical movements result from the interaction between exogenous impulses and the endogenous dynamics of the economic system. This idea has been advanced since the 1970s, with the birth of New Classical Economics (Lucas, 1972; 1973 and 1977), which gave a fundamental role to the problem of imperfect information and rational expectations in explaining economic fluctuations. In fact the economic fluctuations then deserve to be clarified on the basis of a rigorous and coherent real-time structure to facilitate better political, economic and financial decision-making.

From the 1980s onwards, as an extension of New Classical Economics, the theory of the real business cycle (TCR) was developed with the work of (Kydland and Prescott 1982; Long and Plosser 1983). This theory aims to show that cyclical movements in economic activity result from the optimal responses of economic agents to real shocks, essentially technological shocks, in a context of rational expectations. With the above-mentioned dependence, the question of business cycle synchronization became of major interest worldwide in the 1980s. As a result, it seems that business cycle theories have gradually evolved in different directions. Indeed, theoretically, the business cycle has been the subject of a number of recent works, notably (Grigoras and Stancieu, 2016; Mattera and Franses 2023; Stiblarova, 2023) who have defined the business cycle as “*an aggregate phenomenon that has led to recurrent and persistent variations in economic activity as a whole*”. This does not mean pretending that there is a given periodicity and amplitude of expansion and recession phases, but simply certain regularities in the variations of economic activity.

Although, the question of business cycles in general, has been accompanied and sometimes initiated by its growing interest. Recently, the scope of business cycle synchronization has expanded considerably in both developed and developing countries (Yuwen Dai, 2014; Benhida, 2015; Matesanz and Ortega, 2016; Dua, and Tuteja, 2023). The economic crises and changes that have hit the global economy have given particular attention to the search for points of reflection on the origins of economic fluctuations and the identification of the characteristics of business cycles, with an emphasis on the explanatory factors of the cyclical transition mechanism between countries.

In this sense, the contribution of this article is to answer the central question of the cyclical synchronization of the Tunisian economy on the one hand, and to compare it with that of Euro zone countries such as Germany, Italy, France and Spain on the other. To answer this question, several statistical and econometric methods based on classical and modern approaches compete to establish a satisfactory empirical description of business cycle synchronizations.

The article proceeds as follows: Section 2, describes the characteristics of the Tunisian economy and the Euro zone. Section 3, presents a brief review of the empirical literature. Section 4 presents the model and describes the database. Section 5 contains the empirical results, and Section 6 concludes.

## 2. Literature review

In the recent empirical literature, numerous studies have tackled the subject of business cycles, more specifically the concept of business cycle synchronization, which is of major interest to economists and conjuncturists. In this context, the answer to the question of business cycle synchronization relies essentially on understanding economic fluctuations and comparing cycles between countries, which are the subject of numerous studies such as (Dufrenot and Keddad, 2014; Benhida, 2015; Grigoraş and Stanciu, 2016; Monnet and Puy, 2016; Elgahry, 2016; Compos et al. 2019; Beck, 2021).

Research into cyclic timing analysis has increased significantly over the last decade. Indeed, among the most recent studies, we can find the works of (Beck, 2021; Arčabić and Škrinjarić, 2021), which often reach very different conclusions. The difference in the variables used and the methods of assessing synchronization is the most important part that can explain this difference. In this respect, Arčabić and Škrinjarić, (2021) show that 50% and 90% of the variation in output explains the Euro zone business cycle. The falls were particularly detected during the 2007-2016 period of the great recession. This finding limited national stabilization policies. After the great recession, business cycles became more synchronized between these Euro zone countries. These business cycle externalities are beneficial for the creation of a common monetary policy in Europe. A different approach is that suggested by Compos et al. (2019) who show that synchronization increased by 50% between European countries pronounced particularly after the introduction of the euro in 1999 and that this increase was more noticed specifically in Euro zone countries.

Benhida (2015) studied the synchronization of business cycles in Morocco with the major Euro zone countries, using the correlation index on the one hand, and Bry-Boshan's (1971) parametric method on the other. These methods were adopted by Benhida (2015) to detect both turning points in cycle activity and to determine the degree of cyclical synchronization between Morocco and Euro zone countries. These approaches attracted the attention of several researchers after the 1970s, notably (Elachheb, 2010; Hassad and EL Ghak, 2010).

In this sense, the question of cyclical synchronization between European and North African countries occupies a central place in the empirical literature. That's why several researchers, such as Elachheb (2010), Medhioub (2011) and Knani (2012), have focused on this debate in the Tunisian economy and that of Euro zone countries. They studied the degree of cyclical correlation between Tunisia and certain Northern Mediterranean countries on a monthly basis from January 1994 to December 2007. In their analysis, these authors used several methods, including Harding and Pagan's (2006) concordance index method and the non-linear approach based on regime change models. The results show a degree of convergence between the Tunisian economy and those of Mediterranean countries, implying that Tunisian industrial cycles are perfectly synchronized with those of Euro-Mediterranean countries.

Elachhab (2010) also attempted to assess and determine the causes of cyclical synchronization/de-synchronization between Tunisia and its main European partners. The

results of this study showed that there is a positive and significant impact of the Tunisian cycle with France, essentially linked to the greater intensity of their bilateral trade and the similarity of their economic policies. On the other hand, the result is not verified for the case of Tunisian cycles with Italy and Germany cycles. Some studies have reported the fragility of bilateral trade, which could be explained by dissimilar supply structures and the decline in its trade with these two countries. (Knani, 2012).

Similar to Elachheb (2010), Knani (2012) examined the degree of cyclical correlation between Tunisia and its European partners, such as France, Italy and Germany. He used Harding and Pagan's (2006) approach and (ARDL) model to estimate the long-term effects of financial, trade and common factors on the synchronization of economic activities. The results of this study showed an average synchronization of around 50%, and demonstrated the existence of long-term negative effects of bilateral trade and positive effects of common factors on the correlation between Tunisia's economic fluctuations and those of its main partners.

As suggested by De Haan et al., (2008), there is no single method of analysis, and no consensus on how to proceed. In this context, we use two approaches to address our research problem: the classical approach (Bry-Boschan, (1971) and the non-linear approach Hamilton, (1989), which changes the parametric Markovian regimes, with the aim of identifying the characteristics and synchronization of business cycles between the Euro zone countries and Tunisia.

### 3. Methodology and database presentation

#### 3.1. Methodology

In this research, we adopted a non-parametric procedure from Bry-Boschan (1971)<sup>(1)</sup> and a parametric method based on a non-linear model (MSVAR) from Hamilton (1989). In particular, the Markov regime-switching processes developed recently in economics by Hamilton (1989) have proved to be well suited to detecting the characteristics of international business cycles. Indeed, in empirical research, a number of authors have taken up the Markov regime-switching model in the analysis of business cycles, including Phillips (1991), who treats the multivariate model on two countries and with two regimes. Following the same approach, Filardo and Gordon (1994) enriched their studies by introducing leading indicators for two-regime trivariate model to predict turning points.

The innovation of this model lies in the presence of unobservable common factors that possess their own dynamics governed by a k-regime Markov chain of a discrete, stochastic and unobservable nature, dealing with the state of the economy of the countries in question (Tunisia, Germany, Italy, France, Spain and the euro zone). To this end, we use a multivariate three-regime model with a regime-dependent intercept and covariance<sup>(2)</sup> to find out whether there are conditions under which a common business cycle can be asserted between these countries. The importance of the markov chain model specifications that enable us to generate statistically and economically significant results.

Based on Hamilton's (1989) model, the general framework of the model is written as follows:

$$Y_t = \mu(S_t) + \sum_{j=1}^p \phi_j(S_t)(Y_{t-j} - \mu(S_{t-j})) + \varepsilon_t \quad (1)$$

where  $(S_t)$  follows a first-order Markov chain with values in the countable set  $[1, \dots, K]$ . where  $\varepsilon_t$  is a centered white Gaussian noise process of variance-covariance matrix, of dimension  $(N, N)$  and where  $\phi_1(S_t), \dots, \phi_p(S_t)$  are  $(N, N)$  matrices describing the model's dependence on the regime  $(S_t)$ .

As noted by (Medhioub, 2015; Moradi, 2016; Dua, and Tuteja, 2023), the basic idea of the MSVAR model is that the variable  $(S_t)$  is specified to the K-regime Markov chain process. This means that the current regime  $(S_t)$  depends only on the regime of the previous state  $(S_{t-1})$ , for  $i, j = 1, \dots, K$ :

$$P(S_t = j / S_{t-1} = i, S_{t-2} = k, \dots) = P(S_t = j / S_{t-1} = i) = P_{ij} \quad (2)$$

$(P_{ij})$ ,  $j = 1, \dots, k$  is the probability of moving from state  $i$  at date  $t-1$  to state  $j$  at date  $t$ . Probabilities  $(P_{ij})$  are also called transition probabilities; they measure the probability of remaining in an identical regime or, on the contrary, of changing regime.

The transition probabilities that can be indicated in the transition matrix  $(N, N)$  are denoted by  $P$ . Indeed, as pointed out by (Hamilton, 1989; Medhioub and Eleuch, 2013; Dua, and Tuteja 2023), the transition from state  $i$  to state  $j$  in the Markov regime-switching model is probabilistic. The transition probability matrix is written as follows:

$$P = \begin{bmatrix} P_{11} & P_{21} & \dots & P_{N1} \\ P_{21} & P_{22} & \dots & P_{N2} \\ \vdots & \vdots & \dots & \vdots \\ P_{1N} & P_{2N} & \dots & P_{NN} \end{bmatrix} \quad (3)$$

The properties of probabilities are:

- $(P_{ij}) \geq 0 \forall i, j \in [1, \dots, k]$  i.e. probabilities are not negative
- $\sum_{j=1}^k P_{ij} = 1 \forall j = 1, \dots, k$  is the probability of the economy passing through one of the  $K$  states. The sum of the probabilities is equal to unity.

Given that there are three states or regimes. To model the process we choose a specification of this model based on Markov Switching Intercept Autoregressive Heteroscedasticity (MSIAH) or a Markov mean-switching heteroscedasticity (MSMH) specification. Other process types, such as MSI and MSIA, are adopted to verify the absence of regime shifts

in autoregressive parameters (A) and heteroscedasticity (H). Other specifications are MSM and MSMH, introduced by Hamilton (1990). The former contains regime-dependent means while MSMH, while the latter, includes regime-dependent means and variances.

Once or regimes are recognized. It is also possible to establish a multivariate vector autoregression (VAR) model for the industrial production growth rates of Tunisia, France; Italy, Spain, Germany and the euro zone. To do this, we relied on a univariate Hamilton model, focusing on which of the MSIAH/ MSIH/ MSI/ MSIA/ MSMH/ MSM specifications devoted to this model. Usually, referring to this univariate model encountered by Hamilton (1989), the various alternative specifications discussed in (Guidolin, 2011; Dua and Tuteja, 2023) under the name of Markov intercept autoregressive heteroscedasticity model (MSIAH) is written in the following form:

$$Y_t = \mu_{S_t} + \sum_{j=1}^k \phi_{S_{tj}} Y_{t-j} + \sigma_{S_t} \varepsilon_t \quad (4)$$

The Writing of the specification of Markov Switching Intercept Autoregressive (MSIA) Model:

$$Y_t = \mu_{S_t} + \sum_{j=1}^k \phi_{S_{tj}} Y_{t-j} + \sigma \varepsilon_t \quad (5)$$

The Mean Markov Switching Heteroscedasticity (MSMH) specification for the k-regime MSVAR model is as follows:

$$Y_t - \mu_{S_t} = \sum_{j=1}^k \phi_j (Y_{t-j} - \mu_{S_{t-j}}) + \sigma_{S_t} \varepsilon_t \quad (6)$$

The expression for the Markov Switching Mean (MSM) model specification at K regime is written as follows:

$$Y_t - \mu_{S_t} = \sum_{j=1}^k \phi_j (Y_{t-j} - \mu_{S_{t-j}}) + \sigma \varepsilon_t \quad (7)$$

The Markov Switching Intercept (MSI) Model:

$$Y_t = \mu_{S_t} = \sum_{j=1}^k \phi_j Y_{t-j} + \sigma \varepsilon_t \quad (8)$$

The Markov Switching Intercept Heteroscedasticity (MSIH) Model:

$$Y_t = \mu_{S_t} = \sum_{j=1}^k \phi_j Y_{t-j} + \sigma_{S_t} \varepsilon_t \quad (9)$$

The Estimation of MSVAR (1) model parameters by the maximum likelihood (ML) method, which is based on a version of the Expectation Maximisation (EM) algorithm developed by Hamilton (1990) and Krolzig (1997). The basis of the Expectation Maximisation (EM) algorithm is a 2-step process used by Dempster et al. (1977): In the



first step, “Expectation (E)”, we assume that there are three states or regimes in the world and the probabilities of the hidden states of nature are estimated. Whereas, in the second step (M) the probabilities estimated by step (E) are used in the estimation of the model parameters and the likelihood function is maximized. Once the parameters have been estimated from the data, we obtain the filtered probabilities and the smoothed probabilities<sup>(3)</sup> noted  $P[S_t = j/(y_t, y_{t-1}, \dots, y_1)]$ , for  $j = 1, 2, 3$ . These smoothed probabilities are used to classify observations between regimes and to date the business cycle. Typically, the rule applied in Hamilton's (1989) model is to assign the observation to time  $t$ , according to the highest smoothed probability.

$$m^* = \arg \max P[S_t = j/(Y_t)] \quad (10)$$

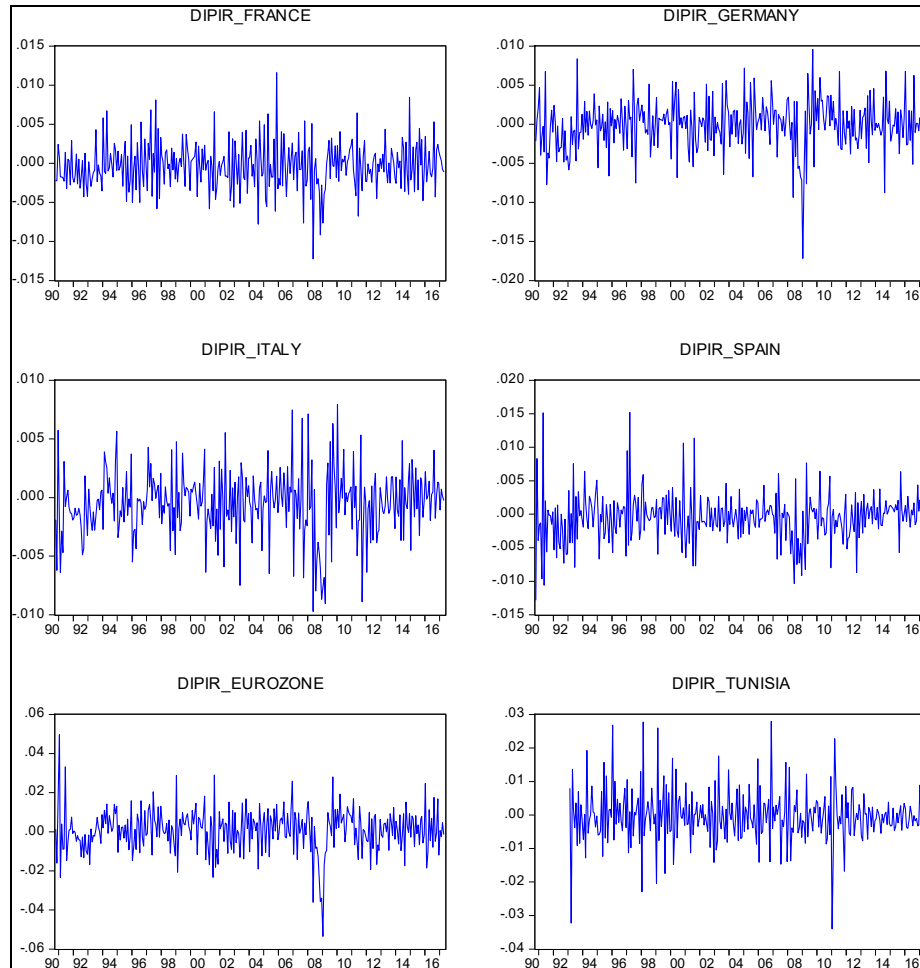
Following the articles by (Hamilton, 1989; Damette and Rabah, 2010; Medhioub and El Euch, 2013), given the existence of two regimes, the dating and identification of business cycle turning points for  $j = 1, 2$  at date  $t$  is based on the following classification rules<sup>(4)</sup>. |For Peaks, both filtered and smoothed probabilities verify this relationship  $P[S_t = 1/(y_t, y_{t-1}, \dots, y_1)] > 0.5$  and  $P[S_{t+1} = 2/(y_t, y_{t-1}, \dots, y_1)] < 0.5$ , and vice versa for Troughs  $P[S_t = 1/(y_t, y_{t-1}, \dots, y_1)] < 0.5$  et  $P[S_{t+1} = 2/(y_t, y_{t-1}, \dots, y_1)] > 0.5$ .

### 3.2. Database

To examine the business cycle synchronization between Tunisia and the Euro zone countries, we use the Industrial Production Index (IPI) series<sup>(5)</sup>, which is considered to be a fundamental statistical indicator that measures variations in the quantities produced in industries over a short period. Indeed, the series of variables in first difference extends over a monthly period from January 1, 1990 to May 31, 2017 (base 100 in 2010), (Figure 1). Data were collected from the National Institute of Statistics (INS) and the OECD, covering six countries (Tunisia, Germany, Italy, France, Spain and the Euro zone).

In this study, the statistical description of the variables presented in Table 1 leads to several major comments. The analysis of standard deviations shows that the IPI of the majority of countries fluctuates enormously from one month to the next. The coefficient of asymmetry or skewness, with negative values (Skewness < 0) for each of the series, allows us to conclude that the distributions of the series are asymmetrically spread to the left, with the exception of the distribution of the IPI series for Spain and Tunisia, which are asymmetrically spread to the right, with a positive skewness coefficient greater than 0. At the same time, the same findings are observed for the analysis of kurtosis coefficients, which are low, below 3, with a (Kurtosis < 3) for the majority of series (the IPI of Tunisia, Spain, Italy, France and the Euro zone) are Platykurtic. This low Kurtosis allows us to note that the seasonally-adjusted IPI series present Platykurtic distributions. Furthermore, the probability analysis for the Jarque-Bera statistics, which are all below 5%, leads us to confirm that the data do not follow a normal distribution. Consequently, this distribution rejects the null hypothesis of normality.

**Figure 1.** Variables in first difference



**Table 1.** Descriptive statistics of variables

Designations	IP  <sup>FRA</sup>	IP  <sup>GER</sup>	IP  <sup>ITA</sup>	IP  <sup>SPA</sup>	IP  <sup>EUR</sup>	IP  <sup>TUN</sup>
Mean	1,72e-06	1,57e-05	-1,88e-05	6,78e-06	1,32e-05	1,50e-50
Median	1,047	1,005	1,059	1,074	1,030	1,009
Maximum	1,110	1,051	1,157	1,160	1,054	1,045
Minimum	0,983	0,969	0,963	0,961	0,982	0,922
Standard error	0,00574	0,00893	0,00844	0,00775	0,00851	0,00500
Skewness	-0,54339	-0,65154	-0,48536	0,11031	-0,51253	0,27136
Excess Kurtosis	1,66513	2,61958	1,78756	0,37138	1,38221	-0,52917
Jarque-Bera	40,69077	88,09860	42,58337	1,92041	22,70284	5,24301
Probability	0	0	0	0	0	0
SumSq, Dev,	0,00222	0,00291	0,00210	0,003024	0,02671	0,01106
Observations	320	320	320	320	320	320

Source: author's calculations.

#### 4. Empirical results

##### 4.1. Dating of turning points estimated by the Bry-Boschan method

We applied Bry Boschan's (1971) non-parametric method to the Industrial Production Index (IPI), with the aim of obtaining business cycle turning points. Indeed, the results shown in Table 2 shows that the turning points are different for all countries. To this end, there are clearly defined peaks and troughs for the classic cycle. Indeed, it appears that over the period 1990 to 2017, there are 7 periods of cyclical movement marked by 3 troughs and 4 peaks that are easily identifiable. The first period has four common peaks (1994:12; 1995:1, 2000:05 and 2006:12) relative to the countries (France, Spain, Italy and Germany). But the three common trough dates (1994:1; 1996:12 and 2009:3) are periods of roughly the same duration for Tunisia as for the other Euro zone countries except France.

**Table 2.** *Turning points in the Classic cycle of Tunisia and Euro zone countries*

	France	Germany	Italy	Spain	Euro zone	Tunisia
Trough	1993:12 1997:1 1999:3 2009:4 2014:11 2016 :7	1994:1 1996:2 2002:5 2003:8 2009:4 2013:1	1994:01 1996:12 1999:05 2005:05 2009:03 2014:05	1993:08 1996:12 1999:02 2006:04 2009:03 2013:02	1996:7 1998:12 2003:9 2005:5 2009:4 2013:2	1995:5 1998:1 2003:11 2005:11 2009:3 -
Peak	- 1995:1 1998:5 2000:5 2011:1 2015:10	1991:1 1994:12 2001:2 2002:11 2008:2 2011:7 2016:1	- 1994:12 1997:12 2000:05 2006:12 2011:04	- 1995:01 1998:02 2000:02 2007:03 2009:12	- 1998:1 2000:12 2004:7 2006:12 2011:2 2016:1	- 1997:1 2001:1 2004:9 2007:6 2010:1
(P to T)	- 24 10 100 40 9	36 14 15 09 14 18	- 24 17 60 27 37	- 11 33 10 28 24	- 11 33 10 28 24	- 12 34 14 21 -
(T to P)	- 13 16 21 21 17	- 11 60 06 54 27 36	- 11 12 12 19 25	- 17 14 12 11 9	- 18 24 10 19 22 45	- 20 36 10 19 10
(P to P)	- 40 31 121 57	- 47 74 21 63 41 54	- 36 29 79 52	- 37 24 85 33	- 35 43 29 50 69	- 48 44 33 31
(T to T)	- 37 26 121 61 26	- 25 17 15 68 45	- 35 29 72 46 62	- 40 26 86 35 47	- 29 57 20 47 46	- 32 70 24 40 -

Source: author's calculations.

From an economic point of view, there seems to be little relationship between the duration of a recession or an expansion. As Burns and Mitchell (1947) point out, the duration of cycle phases is at least a few months, without specifying how long. For Bry and Boschan (1971), in their seminal article on cycle dating for the NBER, the identification of turning points follows very clear rules: the minimum duration of a phase is five months, and the minimum duration of a complete cycle, from peak to peak or trough to trough, is fifteen months. By definition, if we look at the empirical literature, we find that these empirical values are found in certain research works or articles which consider a country to be in recession if its GDP growth rate remains negative for two consecutive quarters. Among the works we can cite (Ferrera, 2009; compos et al. 2019; Oman 2019; Arčabić and Škrinjarić, 2021).

Another point for reflection drawn from Table 2 is that there are 05 major periods of recession for Euro zone countries that are easily identifiable: the first recession took place from early June 1995 to late 1996, followed by a slowdown between 1997 and 1999 as a result of the Asian crisis. Then came the third shock, the American recession, which worsened after September 11, 2001 and affected the European economy between January 2002 and March 2003. Finally, the last episode was triggered by the subprime crisis between 2007 and 2009. Focusing on the severity of recession phases, Table 2 shows that the average length of recession is characterized by classic medium-long cycle amplitude for the majority of Euro zone countries, at around 2.5 years for France, Italy and Spain, and 1 year and 2 months for Germany. In the case of Tunisia, on the other hand, the duration of recession phases is short and does not exceed 13.5 months. At this point, following the seminal article by De Grauwe and Ji (2018), most Euro zone countries qualified a period of expansion between the periods 2000 and 2007. But after this date, a crisis known as the “*subprime crisis*” hit the majority of economies worldwide and, in particular, the Euro zone countries. This common shock had a negative impact on these group countries (France, Italy, Germany and Spain), leading to deep and prolonged recessions during this crisis episode. As a result, the movement of the Euro zone cycle is asymmetrical, characterized by stronger cyclical amplitude.

However, for France, the Industrial Production Index (IPI) appears to have a long (peak-peak) cycle with 45.17 months. Whereas for other countries, there is little evidence that average (Peak-Peak) cycle lengths are different, such as in Germany, where the average cycle length is probably lower at 24.29 months. On the other hand, in Italy and Spain, cycles are of roughly the same length, at around 3 years. For Tunisia, cycle lengths (Trough- Trough) are shorter, averaging 27.67 months. As a result, the Tunisian economy appears to be relatively less cyclical than other Euro zone economies, notably those of France, Germany, Italy and Spain.

**Table 3.** Average duration of expansion and recession in the Classic cycle

	France	Germany	Italy	Spain	Euro zone	Tunisia
Recession duration	30.5	15.14	27.5	28.5	15.14	13.5
Expansion duration	14.67	27.71	13.17	10.5	19.71	15.83
Cycle (P to P) Average duration	41.5	42.86	32.67	29.83	32.29	26
Cycle (T to T) Average duration	45.17	24.29	40.67	39	28.43	27.67

**Source:** author's calculations.

Table 3 on the classic cycle shows that, after the great depression, the economic cycles of the Euro zone countries are relatively well synchronized. This high degree of synchronization was revived by the launch of a single currency in 1999. This led to the creation of the Economic and Monetary Union (EMU), which fostered the emergence of a common economic cycle in the Euro zone. Indeed, the implementation of accommodating monetary policies increased synchronization between European countries by 50%, particularly after the introduction of the euro in 1999, Compos et al. (2019). On the other hand, there was little synchronization between Tunisia and the Euro zone.

**Table 4.** *Turning points in the Growth cycle of Tunisia and Euro zone countries*

	France	Germany	Italy	Spain	Euro zone	Tunisia
Trough	1996:9	1996:2	1996:10	1996:07	1996:07	1997:09
	1999:2	1999:4	1999:02	1999:03	1998:12	1999:11
	2003:7	2003:7	2002:01	2002:04	2003:09	2003:06
	2005:5	2005:4	2003:07	2005:06	2005:05	2006:03
	2009:6	2009:6	2005:05	2009:04	2009:04	2009:05
	2012:11	2013:3	2009:06	2013:01	2013:02	2011:04
	-		2013:02		-	-
Peak	1995:3	1995:1	1995:04	1995:02	-	1996:09
	1998:2	1998:5	1997:12	1998:06	1998:01	1998:12
	2000:11	2000:11	2000:09	2000:04	2000:12	2001:01
	2004:7	2004:5	2002:09	2004:02	2004:07	2004:04
	2007:12	2008:2	2004:03	2007:10	2006:12	2007:06
	2011:7	2011:9	2008:01	2011:06	2011:02	2010:03
	2013:7		2011:05	2016:11	2013:04	
(P to T)	18	13	18	17	-	12
	12	11	14	9	11	11
	32	32	16	24	33	29
	10	11	10	16	10	23
	18	16	14	18	28	23
	16	18	17	19	24	13
	-		21		-	-
(T to P)	-	-	-	-	-	-
	17	27	14	23	18	15
	21	19	19	13	24	14
	12	10	8	22	10	10
	31	34	8	28	19	15
	25	27	32	26	22	10
	8	23	23	45	45	24
(P to P)	-	-	-	-	-	-
	35	40	32	40	-	27
	33	30	33	22	35	25
	44	42	24	46	43	39
	41	45	18	44	29	38
	43	43	46	44	50	33
	24	40	40	69	69	37
(T to T)	-	-	-	-	-	26
	29	38	28	32	29	43
	53	51	35	37	57	33
	22	21	18	38	20	38
	49	50	22	46	47	23
	41	45	49	45	46	-
	-	44		-	-	

Source: author's calculations.

A simple comparison of the growth cycle and the classic cycle between Tunisia and some Euro zone countries brings out some important facts that can be observed with a visual examination of Table 4. Indeed, it appears to identify 6 periods of cyclical movement marked by 4 troughs and 2 peaks that are easily identifiable. Starting with the growth cycle troughs that are similar for the majority of Euro zone countries, we can find the following trough points (1999:2; 2003:7; 2005:5 and 2009:6). While, in the case of the Peak points, the hardnesses (2000:11 and 2004:7) are very close for this group of countries (France, Germany and Tunisia).

The identification turning points of growth cycle obtained by the BBQ algorithm highlights several phases and cycles. Indeed, Table 5 clearly shows that the average length of the growth cycle in Tunisia (Peak -Peak) is very close to that identified in the Euro zone (23.29 for Tunisia versus 28.43 for the Euro zone). As Elachhab (2009) points out, over the last thirty years, the financial integration of the Tunisian economy with the Euro zone has been weak (the share of foreign direct investment in GDP was around 1.9% during the period 1970-2000), and it could be argued that it is trade links (import and export) that could explain the bulk of the transmission of European contractions to the Tunisian economy.

**Table 5.** Average duration of expansion and recession in the Growth cycle

	France	Germany	Italy	Spain	Euro zone	Tunisia
Recession duration	15.14	16.83	15.71	17.17	15.14	15.86
Expansion duration	16.29	19.5	14.86	18.67	19.71	12.57
Cycle (P to P) Average duration	31.43	33.33	27.57	32.67	32.29	28.43
Cycle (T to T) Average duration	27.71	34.17	28	33	28.43	23.29

**Source:** author's calculations.

Similarly, there appears to be a fair degree of symmetry in the duration and scale of recession phases in the Tunisian cycle and the Euro zone. The hardness of the slowdown phase for Tunisia is around 15.86, compared with 15.14 for recession phases in this group of Euro zone countries.) Nevertheless, the average duration of expansion phases evolved over the period 1990-2017 at a low rate, not exceeding 12.57 months for Tunisia versus 19.71 months for the Euro zone). These results show that the behavior of the Tunisian growth cycle is similar to that of other countries, with a slight delay compared to the recession phases of the Euro zone cycle. Overall, it also appears that the irregularities of the Tunisian growth cycle are convergent and similar to those observed in the Euro zone countries.

#### 4.2. Dating of turning points estimated by the Markov-Switching model

The identification of classical cycle and growth characteristics for the industrial production index (IPI) of the majority of countries in our sample estimated by the MSVAR model (Table 6), that there are five periods of recession that characterize the state of the Tunisian economy. Indeed, these periods of decline are essentially marked during the periods 1992-1998, 1999-2000 and 2001-2004, as well as for the great financial crisis from late 2007 to early 2009 and from 2009 to mid-2011. All these episodes have occurred in recent years,

the most serious of which have been marked by financial crises, social protests (the Gafsa mining basin revolt against unemployment) and corruption (the nepotism of the Ben Ali clan). Thus, the start of the Tunisian revolution in 2010 and the fall of the Ben Ali regime in January 2011.

According to the results obtained in Table 6, the transition probability matrix estimated by the MS(2) VAR(1) model shows that the “*high-growth regime*” can only be reached through the “*low-growth regime*”. Indeed, the asymmetry of the business cycle in terms of the average duration of the expansion (low and high growth) and recession phases is observed by the transition matrix. For the countries in our sample (France, Germany, Italy, Spain, Tunisia and the Euro zone), the coefficients associated with the transition probabilities are highly significant and fairly differentiated, ranging from 0.989 to 0.739. In the case of France and Spain, the regime-dependent values are not in ascending order (i.e., recession is longer than growth). This is why the persistence of the three regimes is different. In the case of regime 1, where the state is in recession, the coefficients of the transition probability are of duration 0.989 and 0.954, with an average duration of 5.985 and 4.204 months for France and Spain respectively. On the other hand, in the second state characterized by low growth, the probability of transition is significant for the cases of Italy, Tunisia and the Euro zone, at 0.902, 0.984 and 0.920 respectively, with an average expansion duration almost doubling from 2.735 months to 5.151 months. Finally, the last state, which is characterized by high growth, shows a much higher growth rate, 0.939 in the case of Germany, with an average duration of 4.231 months. As we have mentioned, the asymmetry in the economic cycle that characterizes the Tunisian economy and the Euro zone is observed specifically in regime 3. This advantage makes the MSVAR model particularly interesting for capturing asymmetry in the country cycle. Ferrera (2009) argues that Markov change models are particularly useful for determining the asymmetry of Euro zone country cycles. He argues that, since 1970, the duration of expansionary and recessionary phases has been asymmetric, lasting between eight and eleven years in euro zone countries. Similarly, Medhioub and Mraïhi (2011) confirm this result, proving that regime-switching models can capture the business cycle asymmetries of Tunisian economic activity.

**Table 6. Parameter Estimates for Markov-Switching VAR models**

Parameter	MSIH(3)-VAR(2) Specifications																	
	DLIPI <sup>FRA</sup>			DLIPI <sup>Ger</sup>			DLIPI <sup>ITA</sup>			DLIPI <sup>SPA</sup>			DLIPI <sup>EUR</sup>			DLIPI <sup>TUN</sup>		
	Coef.	S-Er	T-Stat	Coef.	S-Er	T-Stat	Coef.	S-Er	T-Stat	Coef.	S-Er	T-Stat	Coef.	S-Er	T-Stat	Coef.	S-Er	T-Stat
$\mu_1$	0.989	0.015	63.824	0.838	9.733	0.000	0.893	0.066	13.487	0.9538	0.030	31.354	0.760	0.207	3.676	0.329	0.358	0.919
$\mu_2$	0.006	0.007	0.835	0.073	0.853	0.394	0.049	0.024	2.010	0.001	0.000	0.000	0.001	0.000	0.000	0.278	0.209	1.330
$\mu_3$	0.001	0.000	0.000	0.013	0.877	0.381	0.023	0.051	0.450	0.069	0.050	1.375	0.060	0.064	0.936	0.071	0.116	0.611
$\phi_{FRA}$	0.010	0.015	0.680	0.100	1.199	0.232	0.106	0.066	1.609	0.046	0.030	1.518	0.239	0.207	1.157	-0.087	0.153	-0.569
$\phi_{Ger}$	0.954	0.044	21.793	0.739	6.850	0.000	0.902	0.048	18.642	0.949	0.029	33.117	0.984	0.012	82.058	-0.157	0.091	-1.720
$\phi_{ITA}$	0.144	0.141	1.019	0.048	1.154	0.250	0.124	0.102	1.217	0.041	0.051	0.795	0.084	0.087	0.970	0.480	0.222	2.162
$\phi_{SPA}$	-0.453	0.116	-3.914	-1.358	5.720	0.000	-0.815	0.182	-4.472	-0.494	0.175	-2.822	-3.054	0.436	-7.005	-0.000	0.073	-0.002
$\phi_{EUR}$	0.106	0.114	0.933	0.263	3.095	0.002	0.032	0.123	0.260	0.101	0.072	1.404	0.156	0.056	2.777	-0.332	0.192	-1.724
$\phi_{TUN}$	0.162	0.172	0.943	0.211	1.920	0.056	1.101	0.245	4.500	0.587	0.287	2.044	-0.700	0.331	-2.118	0.069	0.077	0.9087
$\sigma_1$	0.418	0.103	4.036	0.589	2.427	0.016	0.612	0.165	3.699	1.177	0.258	4.568	0.387	0.302	1.281	0.140	0.162	0.866
$\sigma_2$	1.258	0.228	5.519	0.084	1.927	0.055	0.458	0.105	4.358	0.316	0.060	5.224	0.417	0.052	8.008	0.345	0.126	2.742
$\sigma_3$	0.389	0.227	1.711	0.793	5.601	0.000	0.427	0.129	3.312	1.383	0.484	2.855	0.843	0.312	2.697	1.179	0.248	4.748
Log L	-259.318			-238.777			-232.017			-246.466			-205.466			-243.714		
AIC	-0.084			-0.554			-0.995			-0.292			-0.863			-0.416		
HQ	-0.077			-0.540			-0.981			-0.285			-0.857			-0.395		
SBC	-0.067			-0.520			-0.961			-0.274			-0.846			-0.364		
Matrix of Transition Probabilities																		
	$P_{1i}$	$P_{2i}$	$P_{3i}$	$P_{1i}$	$P_{2i}$	$P_{3i}$	$P_{1i}$	$P_{2i}$	$P_{3i}$	$P_{1i}$	$P_{2i}$	$P_{3i}$	$P_{1i}$	$P_{2i}$	$P_{3i}$	$P_{1i}$	$P_{2i}$	$P_{3i}$
$P_{1j}$	0.989 <sup>*</sup>	0.006	0.001	0.838	0.072	0.013	0.893	0.049	0.023	0.954 <sup>*</sup>	0.001	0.069	0.760 <sup>**</sup>	0.001	0.060	0.506	0.017	0.525
$P_{2j}$	0.010	0.954	0.144	0.100	0.739 <sup>**</sup>	0.048	0.106	0.902 <sup>*</sup>	0.124	0.046	0.949	0.0406	0.239	0.984 <sup>*</sup>	0.084	0.494	0.920 <sup>*</sup>	0.001
$P_{3j}$	0.000	0.0393	0.855 <sup>*</sup>	0.061	0.187	0.939 <sup>*</sup>	0.000	0.049	0.852 <sup>*</sup>	0.000	0.050	0.891 <sup>**</sup>	0.000	0.014	0.856	0.000	0.063	0.474 <sup>**</sup>
Duration	5.985			4.231			5.151			4.204			5.036			2.735		

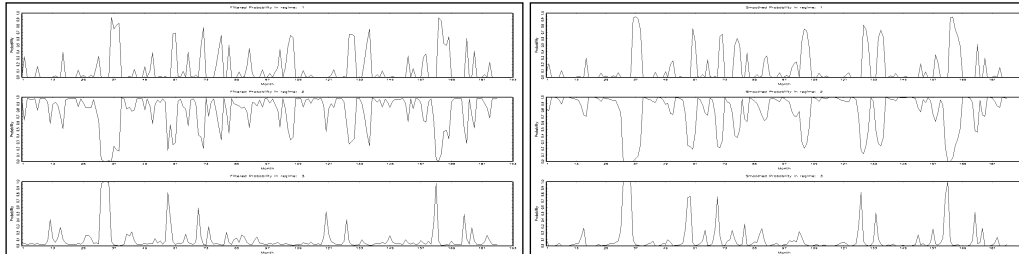
**Note:** DLIPI<sup>FRA</sup> denotes the industrial production index of France, DLIPI<sup>GER</sup> denotes the industrial production index of Germany, DLIPI<sup>ITA</sup> denotes the industrial production index of Italy, DLIPI<sup>SPA</sup> denotes the industrial production index of Spain, DLIPI<sup>EUR</sup> denotes the industrial production index of Euro zone, and DLIPI<sup>TUN</sup> denotes the industrial production index of Tunisian, respectively

*Regime 1 = Recession State.*

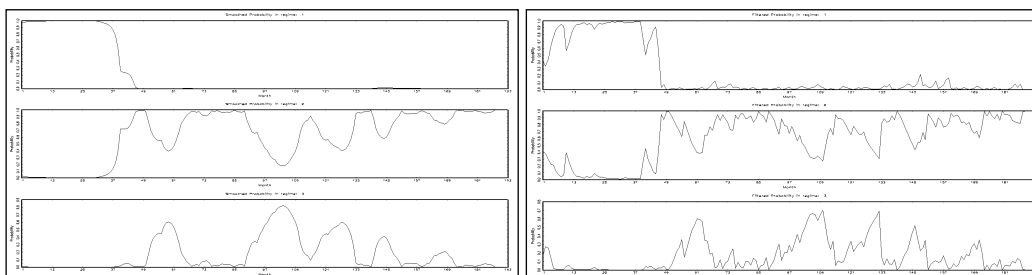
*Regime 2 = Expansion State (with Low growth rate).*

*Regime 3 = Expansion State (with High growth rate).*



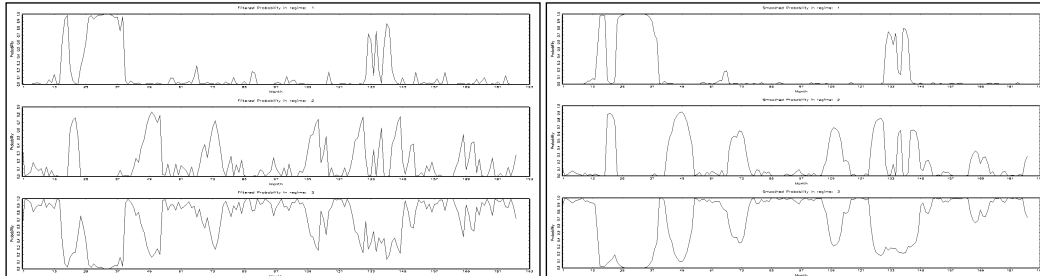
**Figure 2.** Filtered and Smoothed probabilities (MSVAR) with 3 regimes for Tunisia

The figure 2 represents the filtered and smoothed probabilities of 3 regimes for the case of Tunisia. These probabilities illustrate the clear state of the Tunisian economy, with regimes varying between values close to 0 and 1. Indeed, Figure 2 suggests major, abrupt and much shorter bearish periods. The periods of decline that characterize the state of the Tunisian economy according to figure 2 are essentially marked for the following months: September 1992 to April 1993; October 1994 to February 1995; October 1995 to January 1996; September 1998 to January 1999; September 1999 to May 2000; February 2001 to August 2001 and April 2003 to January 2004. In line with the results in Table 5, the coefficient of the probability of recession for regimes 1 and 3 reaches 95%, specifically during the period 1992-1998; 1999-2000 and 2001-2004, and the great financial crisis of late 2007 to early 2009 and 2009 to mid-2011. All these events have taken place over the past few years, and it is clear that this period of stagnation is justified by the decline in real economic activity, which has deteriorated particularly with the succession of crises, most recently the outbreak of the Tunisian revolution in December 2010.

**Figure 3.** Filtered and Smoothed probabilities (MSVAR) with 3 regimes for France

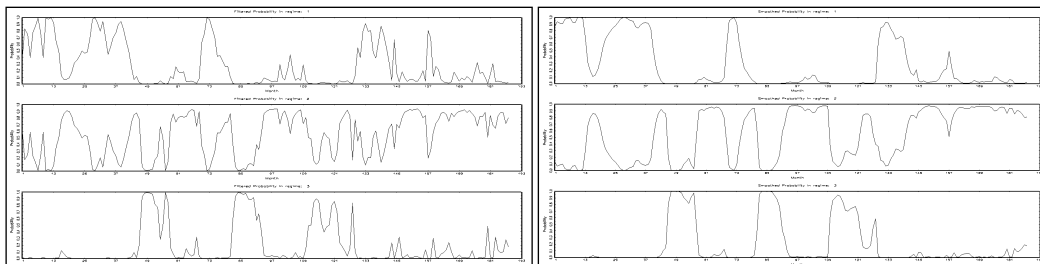
Looking at figure 3, we can see from the analysis of filtered and smoothed probabilities in three regimes for the case of France three major recessions. All these recessions are preceded by an abnormal increase in filtered probabilities: the first recession is observed between 1994 and 1996, the second from early 1998 to 2000. The two oil shocks (smoothed probabilities for the case of 3 regimes worth 0.90 and 0.70 respectively on Figure 3). Finally, the last recession, following the subprime crisis, spans the years 2008 and 2009. This result confirms the work of Damette and Rabah (2010), for the case of France where the model result of Hamilton (1989), identifies three recession dates (1994, 1998 and 2008 to 2009)<sup>(6)</sup>.

**Figure 4.** Filtered and Smoothed probabilities (MSVAR) with 3 regimes for Germany

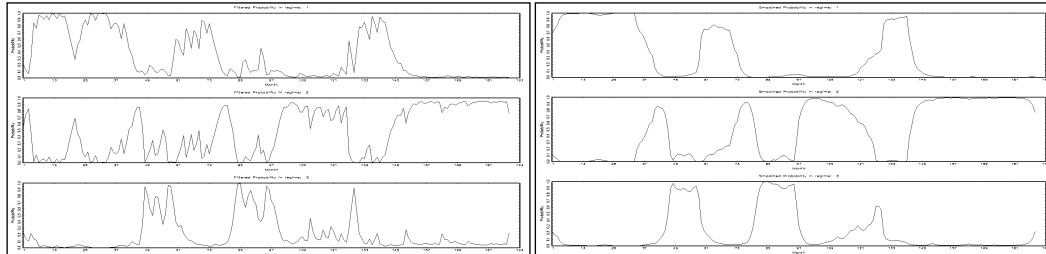


As shown in figure 4, the filtered probability of MS(2)-VAR(1) model describes very precisely 3 recession phases for the Germany case with an average duration of 6.3 months. These short periods of recession that characterize the German economy are marked by this sharp decline specifically between April 1991 to November 1991, December 1993 to May 1994 and July 2001 to December 2001. After these periods of economic instability from 1991 to 2001 there was a substantial recovery period (probability smoothed regime 2). This result is consistent with the main argument of de Castro (2015) for the case of the Portuguese economy.

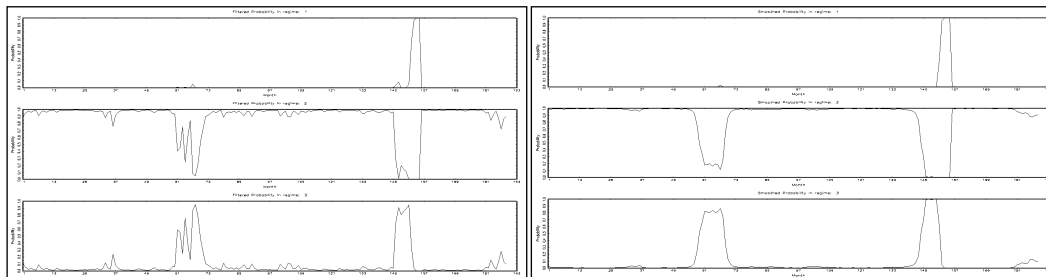
**Figure 5.** Filtered and Smoothed probabilities (MSVAR) with 3 regimes for Italy



The observation in figure 5 of the identification of expansion and recession phases estimated by the MS (2) VAR (1) model, (filtered and smoothed probabilities) for the case of Italy confirms the hypothesis that the conditions for the crisis emerged during this period in the sense that the economy was still operating in one of the other two regimes associated with expansions. In fact, the slowdowns in growth that are signaled by the model. For example, in September 1994, May 1995 and January 1998, the filtered probability did not exceed the 5% thresholds.

**Figure 6.** Filtered and Smoothed probabilities (MSVAR) with 3 regimes for Spain

In the case of Spain, as can be seen from figure 6 and in line with the result in table 5, the filtered and smoothed probabilities increase progressively from the first three years of the '90s, reaching 97% when the recession actually begins in October 1993 in the case of regime 1. Secondly, we should note the significant predictive content of Spain's Industrial Products, since by using this variable exclusively, we obtain a probability of recession already equal to 95% at the end of 1995 in the same regime.

**Figure 7.** Filtered and Smoothed probabilities (MSVAR) with 3 regimes for Euro zone

Based on the estimation result of the MSVAR model presented in figure 7, which describes the recession and expansion phases for Euro zone countries. The shape of this graph shows that the Euro zone IPI can identify 5 major recessions corresponding to significant movements with a probability close to one. The first recession occurred from early June 1995 to late 1996, followed by a downturn between 1997 and 1999 as a result of the Asian crisis. This was followed by the third shock, the American recession, which worsened after September 11, 2001 and affected the European economy between January 2002 and March 2003. Finally, the last episode was triggered by the “*subprime crisis*” between 2007 and 2009. The result of our study confirms some empirical works such as (Burak et al 2003; Ferrera 2009 and Oman 2019), which proves five recession periods. However, it does not confirm other works such as Castro (2015), which proves 4 periods of recession (Medhioub 2015; Damette and Rabah, 2010) for three periods of recession.

## 5. Discussion and conclusion

The beginning of the history of business cycle research has been observed by economists since the 20th century in the work of Hayek (1933) and Von Mises (1933). Indeed, since the 1970s, the NBER has been researching the chronology of the business cycle for the US economy. However, for European countries, the Centre for Economic Policy Research (CEPR) and the Economic Cycle Research Institute (ECRI) has been extending this task to the Euro zone since the 1990s. In developing countries, renewed interest in business cycle analysis, has been developed since the 2000s (Elachheb, 2010; Medhioub and Mraïhi, 2011; Benhida, 2015; Medhioub, 2015). Indeed, the economic crises and changes that have hit the global economy have given particular attention to the search for points of reflection on the origins of economic fluctuations and the identification of the characteristics of economic cycles, with an emphasis on the explanatory factors of the cyclical transition mechanism between countries. With this in mind, we have chosen as the main objective of this article to study the economic cycle in the Tunisian context on the one hand, and to compare it with that of the Euro zone countries on the other, using Bry Boschan's non-parametric method with particular attention paid to Hamilton's (1989) regime-switching models, with a view to producing results that would help policy-makers to make better decisions and adopt appropriate, sound and effective economic policies to cushion falls and avoid periods of depression.

The empirical results of this article show the fragility of the Tunisian economy to international conditions, in particular those of Euro zone countries, by focusing on the explanatory factors of the cyclical transition mechanism between countries Berkmen et al. (2012). Indeed, the growth cycle and classic analysis obtained by applying the BBQ algorithm clearly shows that the average length of the growth cycle in Tunisia (Peak-Peak) is very close to that identified in the euro zone. Thus, the average length of the recession is characterized by classical cycle amplitude that is moderately long for most Euro zone countries, i.e. around 2.5 years. By contrast, the duration of recessionary phases in Tunisia is short, not exceeding 13.5 months. Furthermore, on the basis of the transition probability matrix obtained with regime-switching models (MSVAR). We note that the coefficients associated with transition probabilities are highly significant and quite differentiated, ranging from 0.739 to 0.989. This means that these probabilities illustrate the state of the Tunisian economy, which experiences major downturns, characterized by more stable recessionary situations throughout the study period. However, it should be noted that for the Euro zone economy, the smoothed and filtered probabilities can identify 5 major recessions corresponding to significant movements with a probability close to one. These periods of decline were most marked between the beginning of June 1995 and the end of 1996, followed by a slowdown between 1997 and 1999 in the wake of the Asian crisis. This was followed by a third shock, the US recession, which worsened after September 11, 2001 and affected the European economy between January 2002 and March 2003. Finally, the most serious incident to affect the global economy, and European countries in particular, was the so-called “*subprime crisis*” between 2007 and 2009.

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**Notes**


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- (1) Bry Boschan's (1971) methods were modified by Harding and Pagan (2003) and adapted for the quarterly time series (Elachhab, 2007). The assumptions of the (BB) algorithm procedure for dating a series (monthly period) can be summarized in the following 06 points: (1) A peak (end of an expansion) must be followed by a trough (end of a recession); (2) In the presence of consecutive double peaks, respectively troughs, the higher, respectively lower value is chosen; (03) A phase is the set of monthly periods, that separate a consecutive peak and trough; (04) A cycle is the set of two consecutive phases, i.e. the set of periods from a peak to a peak or from a trough to a trough; (05) The duration of a cycle (Peak-Peak or Trough-Trough) must be greater than or equal to 15 months for monthly data; (06) The duration of a phase (Peak-Trough or Trough-Peak) must be at least five periods for monthly data". Concerning the determination of dating for monthly data, we find that the series achieves a local maximum at date  $t$  if it satisfies the condition:  $\{Y_t > Y_{t\pm k}\}$  and a minimum if  $\{Y_t < Y_{t\pm k}\}$  with  $k = 5$ . The amplitude for a recession phase and for an expansion phases with  $Y_p$  and  $Y_c$  is the values of the series at the peak and trough of the cycle considered. For more details, see Harding and Pagan (2003).
- (2) The MSVAR model was chosen on the basis of the AIC, the HQ criterion and the LR test.
- (3) These two types of probabilities are calculated on the basis of all the information available at date  $T$ .
- (4) These rules are; Peak and trough must alternate; Phase must last at least six months; Cycle must have a minimum duration of fifteen months Medhioub and El Euch (2013).
- (5) The industrial production index (IPI) is seasonally adjusted in Eviews 10.0 using the Census X11 method, and standardized by the consumer price index (CPI).
- (6) cf. fig. 1 pp 146 Damette and Rabah (2010).

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## **Macro analysis of linkages between export, import and economic growth: evidence from the Indian economy**

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**Abstract.** *This paper examines the long run and short run relationship between export and import of goods and services and Gross Domestic Product (GDP) in India from 1991 to 2023 using cointegration analysis, Vector Autoregressive (VAR) test, VAR Granger Causality test and Impulse Response Function analyses. The Johansen cointegration tests find that, there is no consistent, long-term relationship between GDP, export, and imports. Further the result of VAR Granger causality Test shows that export cause effect GDP, Import cause effect GDP, and Export cause import, which confirm that causality between the variables.*

**Keywords:** economic growth, trade, cointegration and causality.

**JEL Classification:** C22, F14, F43.

## 1. Introduction

India's economy is commonly described as a 'mixed economy', which signifies a combination of government regulation in key sectors of industrial growth along with certain liberties for private businesses. Import substitution stands out as the primary feature of India's trade policy. Following independence in 1947, her import policy underwent liberalization, but it was halted by the foreign exchange crisis during 1956-57. However, in July 1991, more comprehensive reforms were introduced to address the balance of payments crisis. Concurrently, India began to further open up its economy to global trade (Konya and Singh, 2008). The World Bank suggested in the early 1990s that trade and macroeconomic policies be drastically altered in order to move the Indian economy into an export-oriented trajectory. Export is regarded an engine of growth, based on economists. However, trade has positive as well as negative impacts on economic growth. According to Dodaro (1991), economies in export-oriented nations would grow more rapidly than those in less export-oriented nations.

Export and import of goods and services is very fundamental source of economic development in Indian economy as India has not self-reliant in all aspects. In this situation, India depends on importing of goods and service from partner countries. Such as India after satisfy domestic needs exporting goods and service. India creates a more income besides it establishes mutual relationship with partner countries, thereby influencing Indian economic growth. Exporting and importing of goods and services reduces poverty, create employment opportunities, improves infrastructure, increases sale and profits, market diversity, commodity and service varieties, customer satisfaction, foreign exchange earnings, government revenue through duties, and ultimately increases standard of living.

## 2. Review of Literature

Chandra (2003) noted that, there exists a long-term relationship between real exports, GDP, and terms of trade in India, as they are cointegrated. The data indicates a bi-directional causal relationship between real exports and real income over the long term. Nevertheless, the causality that flows from income to exports is considerably more robust than the reverse relationship. Income growth promotes export growth, while export promotion strategies positively influence income growth. A balanced approach, emphasizing exports and domestic production, is more successful in India. Dawson (2005) and Singh and Konya (2006) found export-led growth, with GDP and imports jointly Granger-causing exports.

Guntukula's 2018 study on India's export, import, and economic growth found a long-term relationship and bidirectional causality between exports and economic growth, confirming the existence of this relationship. Devkota (2019) and Reddy (2020) found that a long-term equilibrium relationship and a bidirectional causality between economic growth and exports and imports. The study also confirmed that neither exports nor imports significantly boost India's economic growth, contradicting the validity of the ELG, growth led export (GLE), and import led growth (ILG) hypotheses.

Singh and Kumar (2020) showed that Johnson cointegration test revealed a long-term (1995 to 2018) cointegration between India's GDP, exports, and imports. The VECM

Granger causality test reveals a bidirectional relationship between India's GDP and exports, while a unidirectional relationship exists between GDP and imports, affecting India's export-import policy.

Sharma and Panagiotidis (2003) and (2005) reanalysed India's growth sources from 1971 to 2001, focusing on the export-led growth using Engle-Granger and Johansen approaches to examine cointegration of exports and GDP, Granger growth impact, and macroeconomic shocks. It contradicts recent ELG hypothesis, but supports it using the Johansen approach. It also argues against the Granger hypothesis and highlights India's import substituting economy. Singh (2008) and Paul, and Das (2012) both found no-cointegration between Indian exports and imports between 1949-50 and 2004-2005, indicating that India's macroeconomic policies have failed to achieve long-term equilibrium, violating its international budget constraint. Export growth significantly influences output growth, but the opposite is not true.

Kumari and Malhotra (2014) observed no long-term equilibrium relationship between exports and GDP per capita in India, supporting the Export-led Growth Hypothesis. Khemka et al. (2018) revealed that exports don't significantly impact economic growth in the long run, but their short-term impact is significant. It suggests enhancing domestic demand and capital accumulation for long-term growth, rather than export enhancement. Javed and Farhat (2022) also found no evidence of export-led growth. The VAR model and Granger causality test confirm GDP leads to long-term export growth.

Many studies examine the export, import and GDP relationship for India, but the results are inconclusive. It is therefore clear that the evidence regarding exports, imports and economic growth nexus is rather ambiguous and results are mixed. Some studies included imports and some studies excluded imports, there are gaps in the study period. So, the present study examines the trade of goods and services and their relationship with GDP in India during 1991 to 2023.

### **3. Methodology**

#### **3.1. Data**

The study uses secondary data from 1991 to 2023. Dash (2009) and Paul and Das (2012) highlighted that liberalization has a significant role in India's export-led growth, so the study focuses on the post-liberalization period. The research information gathered from the World Development Indicators, World Bank Data Bank and measures economic growth using GDP aggregate series, export and import data based on current US\$.

The study transforms GDP, Export, and Import data into natural logarithms to examine stationarity, and employs the Johansen cointegration test.

#### **3.2. Unit Root Test**

Before testing for Johansen cointegration econometric methodology needs to examine the stationarity for each individual time series. For this study used Augmented Dickey Fuller unit root test (Dickey and Fuller; 1979, 1981) at the levels and first differences of the

variables. The ADF statistics are calculated using Fuller's table's critical values. If the test statistic is less than the critical value, the null hypothesis is rejected, indicating non-stationary or non-integrated series of order zero. A variable is considered integrated of order zero if it is stationary without differencing, and order one if it is stationary only after the first difference. Having concluded from the ADF results, each time series is non-stationary at level, but the series have been found to be stationary at first difference i.e. integrated of order one I(1).

### 3.3. Johansen Cointegration Test

Through cointegration, a linear combination of two or more time series can be stationary even though they are not stationary separately. Economically, cointegrated variables have a long-term, equilibrium relationship between them (Gujarati 2010). The Engle Granger approach and Johansen-Juselius can be used to study the cointegrating relationship between variables with unit roots and same order.

This study applies Johansen cointegration test to find the long-run relationship among the economic growth, exports and imports, (Johansen, 1988; and Johansen and Juselius, 1990). The study test Johansen cointegration between GDP, export of goods and services and import of goods and services in India. The Johansen method for testing cointegration relies on two statistical measures: the trace test statistic and the maximum eigenvalue test statistic. This methodology evaluates the null hypothesis of no cointegration in contrast to the alternative hypothesis that suggests the presence of cointegration. The decision to reject or accept the null hypothesis is determined by the p-value and the comparison of the trace statistics with the critical value, as well as the maximum eigenvalue statistic with its corresponding critical value.

$$\lambda_{\text{trace}}(r) = -T \sum_{i=r+1}^n \ln(1 - \lambda_i)$$

$$\lambda_{\text{max}}(r, r+1) = -T \ln(1 - \lambda_{r+1})$$

Where,

The symbol  $\lambda$  represents the  $i$ th largest eigenvalue of a matrix, and  $T$  denotes the number of observations. Additionally,  $\lambda_i$  signifies the  $i$ th latest established correlation, while  $\lambda_{r+1}$  corresponds to the squared eigenvalue of the  $(r+1)^{\text{th}}$  largest eigenvalue. The  $\lambda_{\text{trace}}$  test is employed to assess the null hypothesis  $r = 0$  against the alternative of  $r > 0$ , whereas the  $\lambda_{\text{max}}$  test is utilized to evaluate the null hypothesis  $r = 0$  against the alternative of  $r = 1$ .

### 3.4. Vector Autoregressive

In this investigation, the three variables GDP, Export, and Import are found to be non-cointegrated, thereby allowing for the implementation of a Vector Autoregressive (VAR) Model. The study uses a VAR model to analyse the dynamic impact of unitary shocks on macroeconomic variables, focusing on the first differences of these variables. A VAR representation is utilised in order to analyse the dynamic impact of random disturbances on the system of variables. VAR is a statistical model that captures the relationship between multiple quantities over time, generalizing the single-variable autoregressive model to include multivariate time series.

The demonstration will perform by using a VAR model, which can be written as the following,

$$GDP_t = \beta_0 + \sum_{i=1}^p \beta_{1i} GDP_{t-i} + \sum_{i=1}^p \beta_{2i} EXPORT_{t-i} + \sum_{i=1}^p \beta_{3i} IMPORT_{t-i} + \epsilon_{1t}$$

$$EXPORT_t = \beta_0 + \sum_{i=1}^q \beta_{1i} EXPORT_{t-i} + \sum_{i=1}^q \beta_{2i} GDP_{t-i} + \sum_{i=1}^q \beta_{3i} IMPORT_{t-i} + \epsilon_{2t}$$

$$IMPORT_t = \beta_0 + \sum_{i=1}^r \beta_{1i} IMPORT_{t-i} + \sum_{i=1}^r \beta_{2i} GDP_{t-i} + \sum_{i=1}^r \beta_{3i} EXPORT_{t-i} + \epsilon_{3t}$$

The  $\beta$  short term coefficients and  $p$ ,  $q$  and  $r$  are the log orders,  $\epsilon_{it}$  ( $i = 1,2,3$ ) are serially uncorrelated error terms.

### 3.5. Granger Causality Test

To examine the causal relationship between exports, imports and economic growth in India the study used Granger causality technique proposed by Granger (1969). The Granger causality method involves regressing a variable  $y$  against its own lagged values as well as the lagged values of another variable  $x$ . If the variable  $x$  is found to be statistically significant, it accounts for a portion of the variance in  $y$  that is not explained by the lagged values of  $y$ . This indicates that  $x$  precedes  $y$  in a causal manner and is described as dynamically influencing  $y$ .

### 3.6. Impulse Response Functions

The analysis is extended using the VAR system, generating impulse response functions. A shock to one variable directly affects all endogenous variables through the dynamic structure. An impulse response function (IRF) traces the effect of a one-time shock on endogenous variables.

The construction of the VAR model, along with the estimated impulse response functions, enables the simulation of the effects of shocks on a specific variable and their subsequent influence on other variables. The primary objective of the impulse response function (IRF) is to assess how the model's variables respond or change over a defined time period (Lutkepohl, 2010). In conclusion, the VAR model encompassing "GDP-EXPORT-IMPORT" serves as a suitable representation for illustrating the autoregressive relationships among exports, imports, and GDP in India. This model allows for the identification of nine impulse responses, which assess the impact of shocks on the fluctuations in current or future values of the export, import, and GDP variables.

The study examines long-run and short-run relationships among GDP, export, and import endogenous variables using cointegration analysis, VAR, and response, commonly using Granger Causality and Impulse Response Function analyses.

The research examined the contributions of several researches concerning cointegration, including Sharma and Panagiotidis (2003, and 2005), Bakari (2019), Mukit (2020), and Kumari et al. (2023), as the VAR framework analysis represent a multifaceted investigative approach.

#### 4. Results and Discussion

Table 1 shows summary of the data, for this analysis data take as form of log.

##### 4.1. Summary of the Data

**Table 1.** Summaries of the Data

	LNGDP	LNEXPORT OF GOODS AND SERVICES	LNIMPORT OF GOODS AND SERVICES
Mean	27.63875	25.83130	25.94850
Median	27.81242	26.25696	26.43635
Maximum	28.89795	27.38002	27.52294
Minimum	26.32208	23.85630	23.85621
Std. Dev.	0.862297	1.178775	1.212404
Skewness	-0.079775	-0.302567	-0.332498
Kurtosis	1.505707	1.532021	1.544444
Jarque-Bera	3.105257	3.466583	3.521189
Probability	0.211691	0.176702	0.171943
Sum	912.0786	852.4329	856.3006
Sum Sq. Dev.	23.79382	44.46437	47.03757
Observations	33	33	33

Based on this table mean GDP has the highest average value, with exports having a slightly lower mean than imports. The median follows the same pattern as the mean, with GDP being the highest, followed by imports and then exports. The range of values is highest for GDP, as seen from both the maximum and minimum values. The range of exports and imports is comparable, although exports exhibit slightly lower minimum and maximum values in relation to imports. Imports exhibit the greatest standard deviation, signifying the highest level of variability, with exports following closely behind. In contrast, GDP demonstrates the least variability among the three categories. All the variable show minimum in 1991. The maximum in 2023 except import, import has maximum in 2022. All variables exhibit a minor negative skewness and a lower kurtosis compared to a normal distribution.

##### 4.2. Unit Root Test

**Table 2.** Unit Root Test

Variables		Model	Test Statistics	5% critical	p-value	Result
LNGDP	Level	Intercept	-0.456389	-2.957110	0.8871	Do not Reject
		Intercept with trend	-1.513251	-3.557759	0.8038	Do not Reject
	First Difference	Intercept	-5.416042	-2.960411	0.0001	Reject Null Hypothesis
		Intercept with trend	-5.338370	-3.562882	0.0007	Reject Null Hypothesis
LNEXPORT	Level	Intercept	-1.346619	-2.957110	0.5955	Do not Reject
		Intercept with trend	-0.742819	-3.557759	0.9607	Do not Reject
	First Difference	Intercept	-4.135363	-2.960411	0.0031	Reject Null Hypothesis
		Intercept with trend	-4.261866	-3.562882	0.0105	Reject Null Hypothesis
LNIMPORT	Level	Intercept	-1.478985	-2.957110	0.5312	Do not Reject
		Intercept with trend	-0.881841	-3.557759	0.9460	Do not Reject
	First Difference	Intercept	-4.193423	-2.960411	0.0026	Reject Null Hypothesis
		Intercept with trend	-4.291743	-3.562882	0.0098	Reject Null Hypothesis

The test statistics are significant, with p-values below 0.05, indicating the null hypothesis of a unit root can be rejected and the series is stationary at the first difference, it means that they are integrated of order one.

The ADF unit root test indicates that all series are integrated at the first difference, denoted as  $I(1)$ , rather than at the level,  $I(0)$ . The test results indicate that a series of GDP, exports, and imports contain a single unit root, which is necessary for the cointegration test.

### 4.3. Johansen Cointegration Test

**Table 3.** *Johansen Cointegration Test*

Series: LNGDP, LNEXPORT and LNIMPORT

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.341295	24.80454	29.79707	0.1685
At most 1	0.268113	11.86268	15.49471	0.1636
At most 2	0.068107	2.186662	3.841465	0.1392

Trace test indicates no cointegration at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.341295	12.94185	21.13162	0.4576
At most 1	0.268113	9.676021	14.26460	0.2341
At most 2	0.068107	2.186662	3.841465	0.1392

Max-eigenvalue test indicates no cointegration at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

The number of cointegrating relationships can be determined using the trace statistic or the maximum eigenvalue statistic. The findings indicate that the Trace statistic value is less than the critical value of 5%, which means that the null hypothesis of no cointegration, is not rejected. In a similar vein, the Max-Eigen statistic value is less than the critical value of 5%, meaning that the null hypothesis of no cointegration, is not rejected. Thus, the findings imply that there is no consistent, long-term relationship between GDP, export, and imports. This result is contradictory to the findings of Mehta (2015), Guntukula (2018), Devkota (2019), Reddy, (2020), and Singh and Kumar (2020).

Multivariate cointegration analysis over the period of 1963–92 finds that no long-run effect of exports on Indian output by Dhawan and Biswal (1999). They, however, find that a short-run causality from exports to GDP. The study reveals no long-term cointegration relationship between India's exports, imports, and GDP, despite conducting tests with VAR and impulse responses.

### 4.4. Lag Selection Criterion

The VAR model can be applied after demonstrating exogenous variables are not cointegrated, but a lag selection criterion must be explained before construction. The VAR lag order selection criteria are used to select the optimal lag length for the VAR time series model, based on Schwarz Information and Akaike Information criteria.

**Table 4.** VAR Lag Order Selection Criteria

Lag	Log L	LR	FPE	AIC	SC	HQ
0	25.36194	NA	4.74e-05	-1.442706	-1.303933	-1.397469
1	133.0639	187.6099*	8.17e-08*	-7.810575	-7.255483*	-7.629629*
2	142.1037	13.99715	8.31e-08	-7.813144*	-6.841734	-7.496489

\* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

The AIC criteria, which suggests a lag of 2 for the GDP, export, and import of the VAR model, was taken into consideration. The AIC value for lag 2 is the lowest among the computed AIC values. AIC penalizes models with more parameters to avoid over fitting.

#### 4.5. Vector Autoregressive Model

**Table 5.** Vector Autoregressive Test

	LNGDP	LNEXPORT OF GOODS AND SERVICES	LNIMPORT OF GOODS AND SERVICES
LNGDP(-1)	0.637472 (0.27478) [2.31997]	0.507716 (0.44640) [1.13737]	0.552226 (0.51475) [1.07280]
LNGDP(-2)	-0.024127 (0.24433) [-0.09875]	-0.720428 (0.39694) [-1.81497]	-0.851654 (0.45772) [-1.86065]
LNEXPORT OF GOODS AND SERVICES(-1)	0.781686 (0.33423) [2.33878]	1.772257 (0.54298) [3.26393]	1.591117 (0.62613) [2.54119]
LNEXPORT OF GOODS AND SERVICES(-2)	0.249178 (0.38781) [0.64252]	0.108117 (0.63004) [0.17160]	-0.091356 (0.72652) [-0.12574]
LNIMPORT OF GOODS AND SERVICES(-1)	-0.591974 (0.29274) [-2.02219]	-0.781831 (0.47558) [-1.64395]	-0.426590 (0.54841) [-0.77787]
LNIMPORT OF GOODS AND SERVICES(-2)	-0.142494 (0.31465) [-0.45286]	0.045520 (0.51118) [0.08905]	0.145234 (0.58946) [0.24639]
C	3.207012 (1.15752) [2.77058]	2.315259 (1.88050) [1.23120]	2.835922 (2.16846) [1.30780]
R-squared	0.994639	0.992157	0.990091
Adj. R-squared	0.993298	0.990196	0.987614
Sum sq. resids	0.108732	0.286975	0.381595
S.E. equation	0.067309	0.109349	0.126094
F-statistic	742.0666	506.0140	399.6890
Log likelihood	43.63212	28.58929	24.17234
Akaike AIC	-2.363363	-1.392857	-1.107893
Schwarz SC	-2.039559	-1.069054	-0.784089
Mean dependent	27.72160	25.95533	26.07748
S.D. dependent	0.822200	1.104390	1.133011
Determinant resid covariance (dof adj.)		4.51E-08	
Determinant resid covariance		2.09E-08	
Log likelihood		142.1037	
Akaike information criterion		-7.813144	
Schwarz criterion		-6.841734	
Number of coefficients		21	



Based on the above table, LNGDP(-1) has a coefficient of 0.637472 and a t-statistic of 2.31997, suggesting that a 1% increase in LNGDP from the previous period is associated with a 0.64% increase in current GDP, and this is statistically significant. LNGDP (-2) has a small negative coefficient (-0.024127), but its t-statistic (-0.09875) indicates it's not statistically significant. LNEXPOR ( -1) has a coefficient of 0.781686 with a t-statistic of 2.33878, suggesting a strong and statistically significant positive relationship between exports (at lag 1) and GDP. LNIMPORT (-1) has a negative coefficient (-0.591974) and is significant (t-statistic -2.02219), indicating that higher imports reduce GDP in the short run.

In the case of export of goods and services is dependent variable, LNGDP (-1) has a positive but insignificant effect (0.507716, t = 1.13737). LNGDP (-2) has a negative but insignificant effect. LNEXPOR (-1) significant positive effect (1.772257, t = 3.26393), indicating exports are highly autoregressive. LNIMPORT (-1) has a negative but insignificant effect.

Import of goods and services as dependent variable, LNGDP (-1) has a positive but insignificant effect (0.552226, t = 1.07280). LNEXPOR (-1) has a positive and significant effect (1.591117, t = 2.54119), suggesting that exports increase imports. LNIMPORT (-1) has a negative and insignificant effect (-0.426590, t = -0.77787).

The R-squared for the GDP equation is 0.9946, meaning that 99.46% of the variation in LNGDP is explained by the model. All the R-squared values are high, suggesting a good fit.

#### 4.6. VAR Granger Causality Test

After that, the VAR causality test was used to examine the causality between GDP, export of goods and services, and import of goods and services based on the following hypotheses:

H0. Export and Import do not cause GDP.

H0. GDP and import do not cause Export.

H0. GDP and export do not cause Import.

This study identifies two types of cause-effect relationships: individual and jointly variable cause-effect.

**Table 6.** VAR Granger Causality/Block Exogeneity Wald Tests

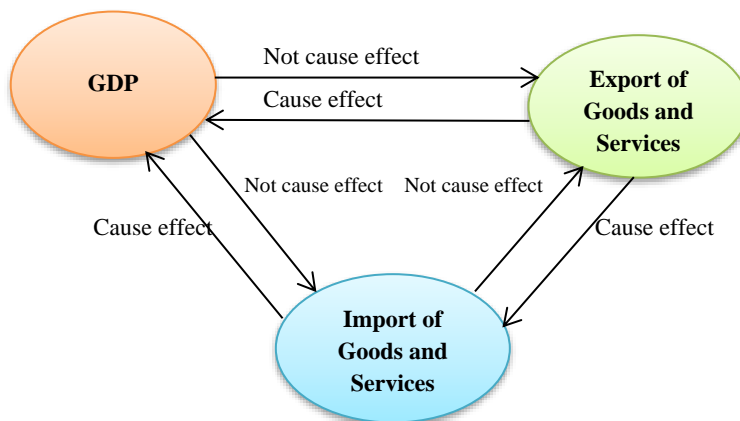
Dependent variable: LNGDP					
	Chi-sq	df	Prob.	Decision	Outcomes
LNEXPOR OF GOODS AND SERVICES	8.984027	2	0.0112	Reject H0	Export cause GDP
LNIMPORT OF GOODS AND SERVICES	6.597414	2	0.0369	Reject H0	Import cause GDP
All	11.36891	4	0.0227	Reject H0	Export and Import cause GDP
Dependent variable: LNEXPOR OF GOODS AND SERVICES					
	Chi-sq	df	Prob.	Decision	Outcomes
LNGDP	4.144379	2	0.1259	Accept H0	GDP cannot cause Export
LNIMPORT OF GOODS AND SERVICES	3.295639	2	0.1925	Accept H0	Import cannot cause Export
All	5.578954	4	0.2329	Accept H0	GDP and Import cannot cause Export
Dependent variable: LNIMPORT					
	Chi-sq	df	Prob.	Decision	Outcomes
LNGDP	4.754551	2	0.0928	Accept H0	GDP cannot cause Import
LNEXPOR OF GOODS AND SERVICES	7.706593	2	0.0212	Reject H0	Export cause import
All	11.11342	4	0.0253	Reject H0	GDP and Export cause import

Table 6 shows individual cause effects are 1) export cause effect GDP. 2) import cause effect GDP. 3) export cause import. 4) GDP cannot cause effect export. 5) import cannot cause effect export. 6) GDP cannot cause effect import. Figure 1 shows individual cause effects.

The following types of jointly variables cause effect, 1) export and Import to GDP: jointly (export and import) cause effect GDP. 2) GDP and import to export: jointly (GDP and import) cannot cause effect export. 3) GDP and export to import: jointly (GDP and export). Figures 2 and 3 show the jointly cause effects relationship. Shortly both exports and imports have a unidirectional causality towards GDP. Also export has a unidirectional causality towards import.

Based on the results, we reject the null hypothesis that export and import do not cause GDP. There is evidence to suggest that both export and import have a significant effect on GDP. We fail to reject the null hypothesis that GDP and Import do not cause export. There is no significant evidence that GDP and Import jointly affect export. Also we reject the null hypothesis that GDP and export do not cause import. Based on the result exports increase GDP, export-friendly policies may help to spur economic expansion. Feder (1983) pinpoints two pathways through which exports affect growth: firstly, through positive externalities of the export sector on the non-export segment, and secondly, through a greater productivity differential within the export sector.

**Figure 1.** Individual Cause effect



**Figure 2.** Joint Cause effect of Export and Import to GDP

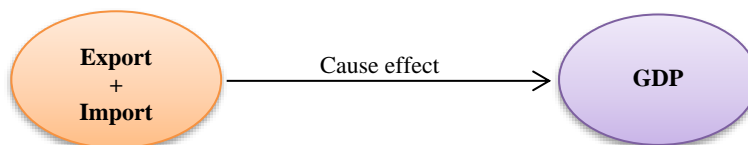
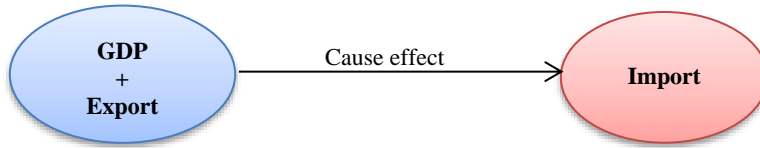
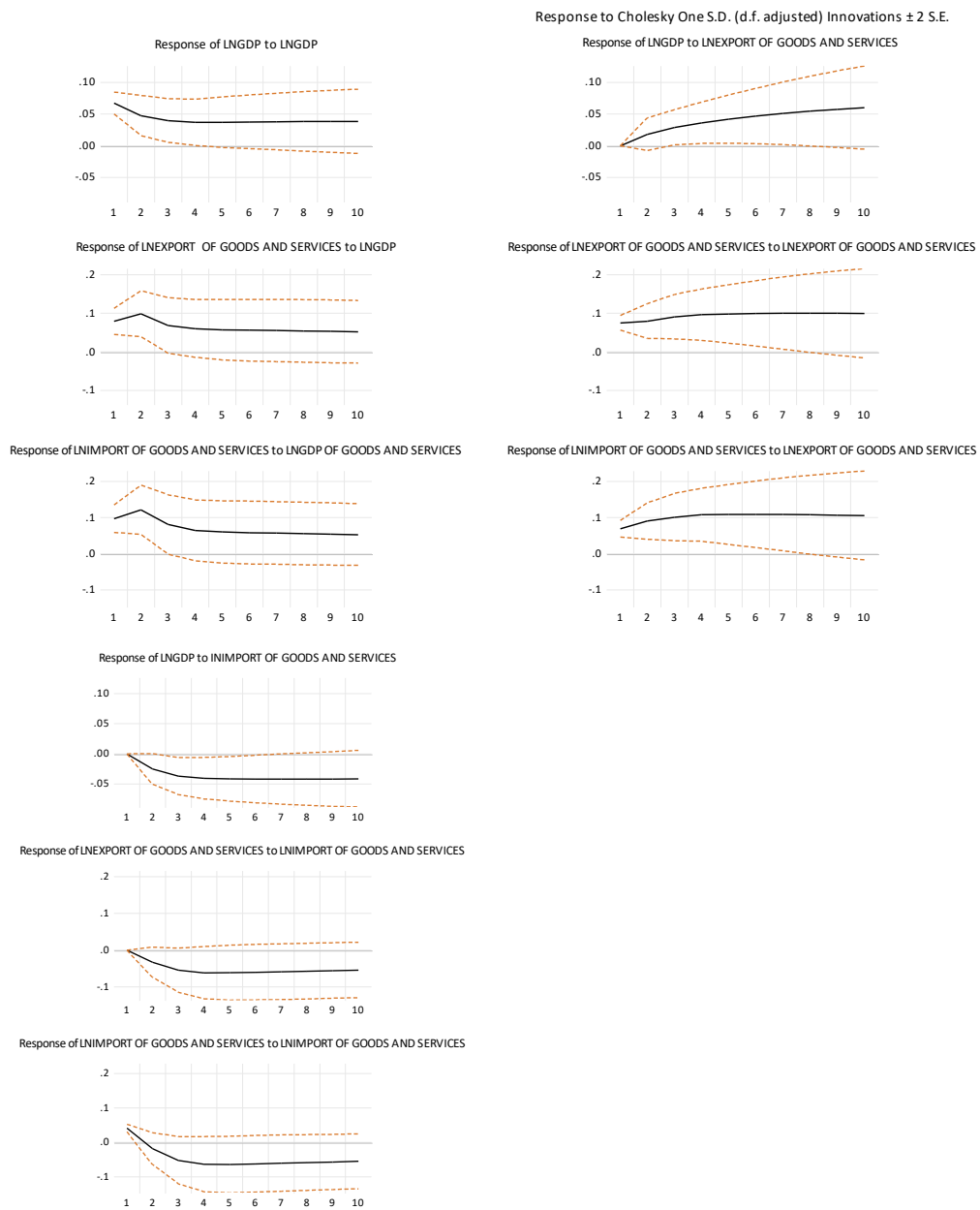


Figure 3. Joint Cause effect of GDP and Export to Import



4.7. Identification of impulse Response function



Export shocks lead to a positive GDP response, peaking around the eighth period, emphasizing exports' significant contribution to economic growth over time. Import shocks initially reduce GDP; likely due to higher imports reduce domestic production and aggregate demand. GDP shocks boost exports due to increased domestic economic activity, production capacity, and global market competitiveness, indicating a positive response to GDP shocks. Import shocks initially cause negative export responses, stabilizing over time due to potential substitution effect, where increased imports reduce domestic demand, negatively impacting exports. Imports respond positively to GDP shocks, as increased domestic activity increases demand for imported goods and services, indicating that economic growth. A shock to exports leads to a positive response in imports, indicating a complementary relationship between exports and imports, as higher exports boost income and demand.

The null hypothesis of the Jarque-Bera test is that the data is normally distributed. The p-values are greater than 0.05. This means there is no significant evidence to reject the null hypothesis, indicating that the data for each component and the joint distribution appear to be normally distributed.

## 5. Conclusion

This study examined the export and import of goods and services and Economic growth/GDP relationship in India from 1991 to 2023 with an objective of the study is to examine long run and short run relationship between exports, import and GDP in Indian economy. All the variables are taken in their natural logarithms. The study used unit root test, Johansen co-integration test, Vector Autoregression (VAR) test, VAR Granger causality test and impulse Response function. The study finds that there is no consistent, long-term relationship between GDP, export, and imports. There is no co-integration in the study, proceed with VAR, VAR Granger causality test and impulse Response function. VAR Granger Causality/Block Exogeneity Wald Tests and impulse responses, it is evident that export growth significantly contributes to GDP, but there is no reverse. There is a cause effect between export and GDP, import and GDP, and export and import. Also jointly cause effect of export and import to GDP and cause effect of GDP and export to import. The finding of export-led growth for India as an outcome of trade liberalisation has implications for other developing economies that aspire to grow fast but confront dilemmas with trade liberalisation policy as observed by Paul and Das (2012). Exports influence imports, but there is no reverse causality from import to export and GDP to exports or imports in this analysis. Based on the result, exports increase GDP, export-friendly policies may help to spur economic expansion in Indian economy. Javed and Farhat (2022) suggested that enhancing economic and political stability in a country can lead to higher GDP growth and improved export performance. Focusing solely on export promotion policies will be ineffective without a stable economy.

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## **From lab to market: how governments and enterprises compose the future of innovation**

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**Abstract.** *This study examines the impact of research and development (R&D) investment on economic growth, distinguishing between private and government contributions. Using data from developed and emerging economies, including the United States, China, Japan, South Korea, Turkey, the United Kingdom, and the European Union, the study analyzes the correlation between R&D spending and GDP growth. Findings indicate that private R&D investments have a strong and more direct effect on economic expansion, particularly in technologically advanced economies like China, South Korea and the United States. These countries leverage private sector innovation to drive productivity and competitiveness. The study underscores the necessity of a balanced R&D strategy, integrating private sector agility with government-led foundational research. Countries that successfully foster collaboration between these sectors achieve sustained economic growth, reinforcing the pivotal role of R&D in national and global competitiveness. The findings provide key insights for policymakers to optimize R&D investments for sustainable economic growth.*

**Keywords:** innovation, economic growth, R&D investment, public-private collaboration, technological development.

**JEL Classification:** I23, I25, I31, O3, O32.

## 1. Introduction

Research and development (R&D) plays a key role in boosting national growth and competitiveness. In recent decades, developed and emerging countries have stepped up inventions in R&D, recognizing their impact on innovation, productivity, and economic well-being. Thus, the research and development sector is considered a key factor in maintaining a competitive advantage and overcoming periods of economic crises by creating new technologies, products and services that stimulate economic sectors. As economies become more digitalized and technological, investment in R&D is becoming a key catalyst for sustainable progress. In addition, government policies that favor R&D can create optimal conditions for innovation and long-lasting economic growth.

Inventions in this sector can come as a source of funding from two main directions: the government sector and the private sector. Government research is usually geared towards long-term projects, supporting scientific and technological infrastructure, and developing fundamental knowledge. Thus, these investments create innovation-friendly ecosystems and enable significant advances in areas such as health, energy production and emerging technologies. Government research can also cover areas where the risks are far too high for the private sector. On the other hand, private sector R&D is mainly directed towards immediate commercial results and applicable innovation, with the objective of increasing the efficiency and competitiveness of companies. In an increasingly competitive business environment, companies invest significantly in technological development to stay positive in the market and respond quickly to technological changes and consumer demands.

The differences between government and private inventions in R&D are visible. The public sector tends to support projects with a broad impact on society, which require long-term investment and are not necessarily attractive to private investors. Instead, the private sector focuses on innovations with rapid profit potential, addressing them by investing in applied research and technological developments that can be commercialized. However, collaboration between the two sectors is essential, as government inventions can boost fundamental research, which the private sector can then harness for commercial purposes. In addition, there are examples of public-private partnerships that have led to breakthrough breakthroughs, such as advances in biotechnology and artificial intelligence, where synergy between the two sectors has been key to progress.

The importance of the R&D sector in economic growth is historically demonstrated, as they facilitate the transition to an economy based on knowledge and innovation. In times of crisis, R&D becomes even more relevant, as it helps to find solutions to complex problems, such as economic recessions, climate change or health crises. In this sense, constant inventions in the field of research and development can help economies become more resilient and maintain their growth even in adverse economic conditions. In addition, increasing development capacities through R&D allows economies to remain competitive in the global market and attract significant foreign investment.



The overall objective of this article is to analyze the relationship between private and government contributions to economic growth. The article investigates how these two types of investments influence GDP. Various countries, which have different economic strategies and different financial capacities, have been selected in order to provide a more coherent and pertinent overview. The inventions of the public sector denote the encouragement that companies have regarding the allocation of sums in avant-garde fields, while the inventions of the state reveal the importance that countries have in their own development process and on the national strategy to become pioneers in certain industries, of national interest.

## 2. Literature review

Econometric analysis of investment in research and development (R&D) has highlighted the strong link between R&D spending and economic growth. Studies on advanced economies show that investment in R&D contributes to increased total factor productivity and long-term technological development (Alam et al., 2019). At the same time, the analysis of emerging economies suggests that high levels of investment in R&D attract foreign capital and stimulate local innovation. However, there are significant differences between the types of financing and their effectiveness on economic growth.

Another aspect of interest is how investment in R&D influences employment and wage levels. Fundamental research indicates that economies with high levels of investment in R&D benefit from a more dynamic labour sector where high value-added jobs are created. Also, companies that invest heavily in R&D are more likely to implement advanced technologies that improve their efficiency and competitiveness in international markets (Kacprzyk & Doryń, 2017).

It has been shown that investments in R&D can have spill-over effects on adjacent sectors. For example, technology companies that invest heavily in innovation can stimulate the creation of related services, such as digital infrastructure, advanced logistics and the production of innovative materials. This generates a multiplier effect that increases the long-term economic benefits.

Another important dimension for the impact of R&D on economic performance is represented by increasing energy efficiency and reducing environmental impact. Technologies developed through investment in R&D can lead to more sustainable production methods and reduced dependence on renewable resources. They not only improve an economy's competitiveness position, but also contribute to global sustainability and environmental goals (Shah, 2024).

Therefore, the impact of R&D on economic performance is multifunctional and extends beyond the simple correlations between expenditure and economic growth. Institutional factors, educational infrastructure and the ability to implement research results are essential elements in determining the efficiency of investments in this field.

Another central aspect of research on investment in research and innovation is how public and private funding alter the effectiveness of innovation. Government investment is essential for the early stages of technological development, providing the necessary infrastructure and resources for large-scale projects. On the other hand, private sector investments are geared towards short-term deliverables and the commercialisation of innovations (Yu, 2021). A comparative analysis of Asian economies shows that privately funded R&D has a more direct impact on firms' competitiveness, while public funding contributes more to creating a robust technological infrastructure.

The analyses suggest that in order to maximise the benefits of investments in this area, a balanced strategic approach between public and private creation is needed. Countries that have succeeded in creating an innovation-friendly legislative framework and fostering public-private partnerships have achieved superior results in terms of economic growth and industrial competitiveness. In addition, the development of policies to support small and medium-sized companies to access funding for research and innovation has been identified as a critical factor for the long-term sustainability of economic growth.

Therefore, the analysis of R&D investments confirms that they are an essential part of economic growth, but their effectiveness depends to a large extent on institutional structure, the level of integration of research policies and the collaboration between the public and private sectors. Econometric models and empirical studies indicate the need for a differentiated approach, adapted to the context of each economy, to ensure a maximum impact of R&D on sustainable economic development.

### 3. Methodology

The study analyzes a sample of countries with developed and emerging economies, selected based on their share of R&D relative to the Burt Domestic Product and their impact on economic growth. The identified countries contain the Member States of the European Union (taken aggregated as an annual average of the entire analyzed interval), China (without consolidated data from Hong Kong), Japan, Russia, South Korea, Turkey, the United Kingdom and the United States of America. The analysis period starts in 2012 and ends in 2023, the last year for which reporting was possible. Comparing these savings allows to highlight effective investment models and provides internationally applicable recommendations. In addition, the analysis of these economies allows for a deeper understanding of government R&D strategies, regional and sectoral differences, and the long-term impact of these investments on sustainable economic development.

The nature of the data used in this study includes official statistics collected from the Eurostat and MFI databases. The data has been processed to ensure consistency and comparability across countries. The data processing source was selected to allow longitudinal analysis of investment trends in the R&D sector and correlation of data with economic developments. In addition to these official sources, research reports published

by various economics, academic studies and additional data from independent sources were also used to improve the robustness of the analysis.

The missing data allocation methods were required in China for the year 2013, for Russia for the years 2021, 2022 and 2023, Japan for the year 2015 and for Turkey for the years 2014 and 2016. The imputation mode was linear interpolation, in order to maintain the integrity of the analysis and avoid distortions in the interpretation of the results. In addition, statistical modelling techniques have been applied to verify data integrity and reduce estimation errors. The approach allowed us to identify more accurately the relationships between growth and the R&D sector, providing solid and fundamental conclusions. The methodology used contributed to the creation of a re-applicable analytical framework, which could be extended to examine other economies or industrial sectors.

#### 4. Finding

By comparing the correlations between R&D expenditure and GDP growth, the study highlights the differences between each country's funding models and their effectiveness in driving innovation and productivity. The results are structured in such a way as to provide a clear picture of the relationship between private R&D and economic growth, respectively between government R&D and its impact on GDP. The analysis allows the identification of trends specific to each economic model and highlights lessons that can be extracted from successful strategies. In addition to quantitative aspects, the interpretation of the results takes into account factors such as the institutional context, economic structure and public policies that influence the efficiency of investments in research and innovation. Next, the data obtained are detailed for each region and the economic implications of different strategic approaches to R&D funding are analysed. This section thus contributes to understanding how research and development can become a key driver of economic growth, depending on the specificities of each economy.

**Table 1.** Level of correlations of R&D investments of private & government companies and GDP

Country	Correlation R&D Business / GDP	R&D Government / GDP
EU - 27	0.19492703	0.27466054
China (w/o Hong Kong)	0.65497721	0.67395858
Japan	0.13515833	0.05176252
Russia	0.33059064	0.15356539
South Korea	0.31087371	0.40160167
Türkiye	0.04225368	0.15887483
United Kingdom	0.03364950	0.00658473
United States	0.43204943	0.17792540

**Source:** author's own process of data using RStudio.

Table 1 shows that the highest recorded values are those of China for both private investment in the research and development sector (0.6549) and government investment (0.6739). The data suggests that the Chinese economy is strongly supported by research and development, with a balanced strategy between the public and private sectors. The high

level of correlation indicates a close relationship between R&D investment and economic growth, which confirms the central role of innovation in China's economic strategy.

The European Union analyzed as an average of the 27 member states registers lower values for both government inventions (0.2746) and private inventions (0.1949). The low values indicate a fragmentation of investment between Member States, where some countries invest heavily while others have a low level of existence. There is also an economic model in which innovation is not the main driver of growth, but rather supported by other economic and industrial policies. It is noted that the analysis was carried out on the basis of aggregated data from all Member States, but the rationale for comparing economic powers requires this. Taken individually, EU Member States have a limited capacity to counter the external policies of the other countries mentioned. Overall, the European Union's *modus operandi* is an aggregate one that takes into account a unilateral move for all participants. As such, the rationale behind it is to compare similar economic centers. The United States of America, for example, can be seen as a totally different mode of government from the European model, but multi-state administration is the central element that entails, as a primary example, the need for European coordinates and the interpretation of EU data at a general level.

At the same time, the data on the correlation of R&D are lower in terms of government investments (0.1779), but higher in terms of private perspective (0.4320). Dependence on private inventions is an observed element that reflects a low government involvement in the R&D sector. As a predominantly capitalist economy, the private sector is encouraged to focus on these areas of development, while the state does not prioritize research inventions.

Japan shows a moderate correlation with a relatively low government contribution. The private sector is the main actor in R&D financing, which corresponds to its economic model based on innovative multinational companies. However, a relatively low correlation indicates that R&D inventions are not the only driver of economic growth.

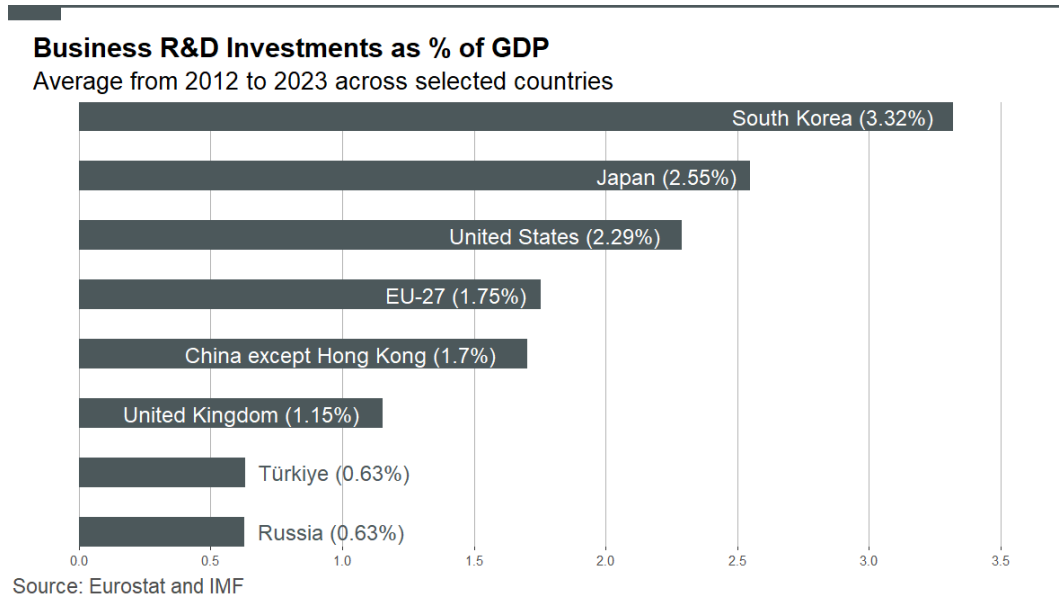
Russia and South Korea have similar values for correlations, but the investment structure is different. In Russia the government contributes to a greater extent, while in South Korea the private sector has a significant involvement. This suggests that while Russia relies on public funding, South Korea has built its economic growth model on private investment, an aspect that explains its success in advanced technological industries.

Turkey and the United Kingdom have the lowest correlation values, indicating a weak link between R&D inventions and economic growth. In the case of Turkey, government inventions are higher, but their impact on the economy seems limited. In the UK, both the private and government sectors have extremely low contributions, suggesting an economic orientation based on services and finance rather than technological innovation.

The fact that some countries are more R&D efficient than others does not mean that the share of the Burt Domestic Product as well as the private percentage of investment are not

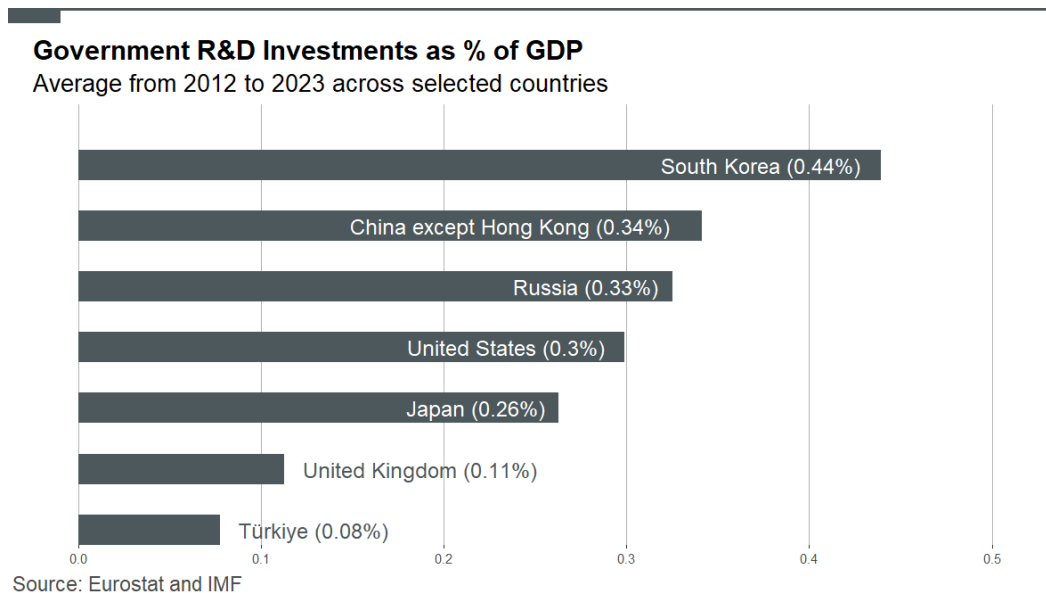
directly proportional. Given that countries differ in structure, economic and strategic complexity, it is also necessary to visualize the percentage values extracted from the nominal values of the data.

**Figure 1.** *Business R&D Investment as % of GDP*



**Source:** author's own process of data using RStudio.

Figure 1 shows that South Korea has the highest share of R&D investment in relation to GDP, both from the private sector and from the government (the values can be seen in Figure 2). The national innovation model combines public support with a significant involvement of private companies, thus strengthening the technological and industrial advantage. Massive investments in the research sector did not arise spontaneously, but are the result of more than two decades of innovation-oriented policies. Since the 2000s, the South Korean government has implemented successive reforms to boost research and development, laying the foundation for a national innovation system. Under Roh Moo-hyun's administration, strategies aimed at transforming the science and technology-based economy. In the following period, the transfer of responsibility to the private sector was emphasized, promoting a more active involvement of companies. Government programs have advocated increasing international completeness, and initiatives such as '557' have set clear targets, such as allocating 5% of GDP to R&D and the development of new strategic technologies. The stimulus policies have led to the consolidation of South Korea's position in leading industries such as electronics, automobiles or biotechnology (Kim et al., 2020).

**Figure 2.** Government R&D Investment as % of GDP

**Source:** author's own process of data using RStudio.

In all the economies analysed, private sector investment in research and development is considered higher than that made by governments. This trend highlights the fact that innovation is mainly driven by private companies, which direct their capital towards the development of new technologies and products with a direct economic impact.

The US clearly illustrates this phenomenon, with an allocation of about 2.29% of GDP for R%D in the private sector, compared to 0.30% of GDP through government funding. This difference underscores the U.S. economy's reliance on corporate investment in technology and innovation.

Europe follows a similar mode, where public research grants have been used mainly as a mechanism to stimulate private investment. Studies show that government subsidies have a complementary effect on private investment rather than a substitution effect, meaning that firms that receive public support also tend to increase their own inventions in R&D (Bronzini et al., 2009).

The European Union adopts a balanced model in terms of research and development funding, combining public and private inventions to ensure the long-term sustainability of innovations. Unlike economies such as the US and South Korea, where private inventions dominate the R&D sector, Europe maintains a more balanced ratio between the two sources of funding. Government research inventions account for about 0.25% of GDP in most Member States, contributing significantly to scientific infrastructure and innovation projects with social impact. This strategy makes it possible to support fundamental

research, universities and public laboratories, while ensuring that the private sector benefits from a stable framework for technological development.

In many European countries, R&D incentive policies aim to encourage the private sector by providing subsidies, tax breaks and public-private partnership schemes. These measures encourage companies to increase their investments in research, generating a multiplier effect on the economy. The data suggest that this blended finance model helps to create a more stable innovation ecosystem that is less vulnerable to market fluctuations (Reinstaller & Unterlass, 2012).

Japan maintains a high level of private investment in research and development, allocating 2.55% of GDP to R&D in the business sector. In contrast, the government contributes only 0.26% of GDP, which indicates a significant dependence on private initiatives for technological advancement. A distinctive feature of the Japanese model is geared towards compensating for demographic decline through innovation. Japan is experiencing a rapidly aging population and a declining workforce, which has led to increased investment in technologies that replace labor-intensive processes. This mode has been reflected in the expansion of the digital sector, automation and digitalization (Sylwester, 2001).

Although private inventions generate sustained economic growth, they have not been able to completely reverse the effect of the decline in the working population. Recent studies suggest that innovation contributes to job creation, especially in the manufacturing sector, but with mixed effects on other industries (Becker, 2015).

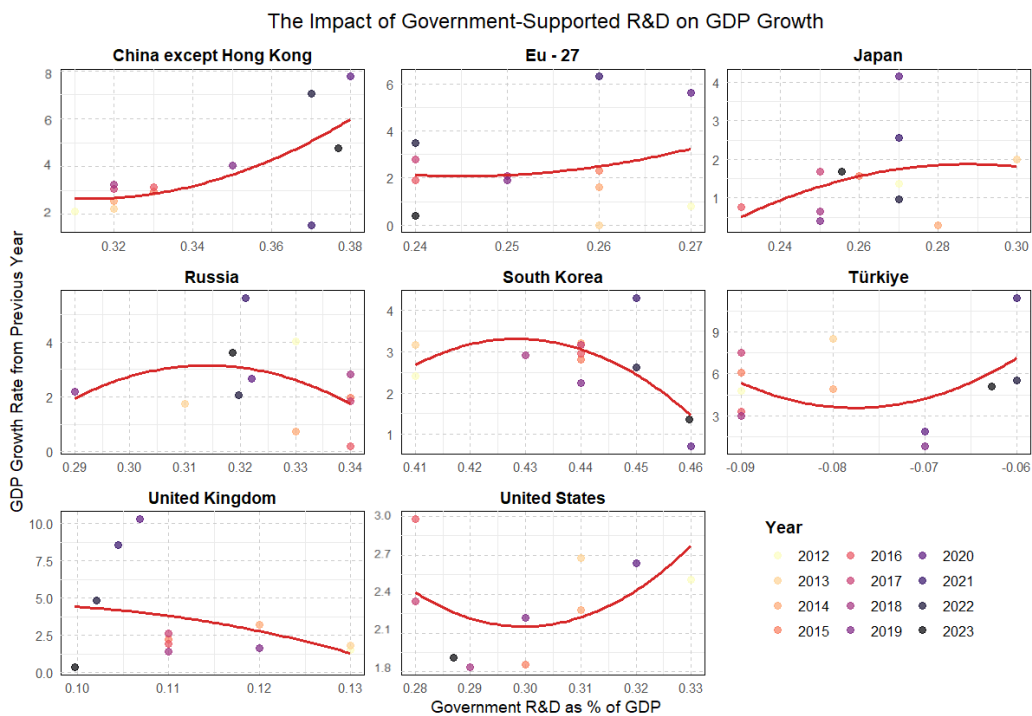
The United Kingdom has one of the lowest levels of investment in research and development among advanced economies, with 1.15% of GDP from the private sector and only 0.11% of GDP allocated by the government. These values confirm a long-standing trend of stagnation in innovation allocation. Unlike other developed countries, the UK has failed to significantly increase its spending on research in the last two decades, which has led to a loss of completeness compared to countries such as Germany, Japan or South Korea. Despite this trend, the UK excels in certain areas, such as academic research and patent production. The number of scientific articles published in relation to GDP is among the highest in the world, which indicates a strong research system but with less economic applicability (Xu & sim, 2018).

Russia allocates 0.33% of GDP to research and development in the government sector, one of the largest public contributions among the countries analyzed. However, private inventions are extremely low, standing at just 0.63%, i.e. a low involvement of companies in innovation. The model reflects the Russian economy's high dependence on state funding and a less dynamic private sector in advanced technological development. On the other hand, public inventions are concentrated in strategic industries, such as defense and energy, which limits the impact of innovation on the overall economy (Doraszelski & Jaumandreu, 2008).

Turkey has the lowest levels of R&D investment among the economies analyzed, with 0.63% of GDP from the private sector and only 0.08% of GDP from the government. This situation indicates a limited involvement of the state and companies in innovation, which affects the competitiveness of the Turkish economy in the long term. In the absence of policies to stimulate R&D, many Turkish companies prefer to import technologies from advanced economies instead of investing in their own innovation capacities. This approach contributes to economic growth based on low labor costs, but without a competitive advantage supported by technology. The Turkish strategy can be understood as one focused on low labor costs rather than on the development of industries based on innovation. Studies show that R&D inventions have not had a significant impact on Turkey's economic growth, suggesting that the economy remains dependent on technology imports and low-value-added industries (Alam et al, 2019).

Almost no relationship is linear in economics, and the R&D sector is no exception to this principle. In Figure 3 and Figure 4 you can see the trend over time of the two indicators. Even if the trend is a downward one, the relationship remains positive for all elements, an aspect to be taken into account for interpretation (Siliverstovs, 2001).

**Figure 3.** *The Impact of Government – Supported R&D on GDP Growth*

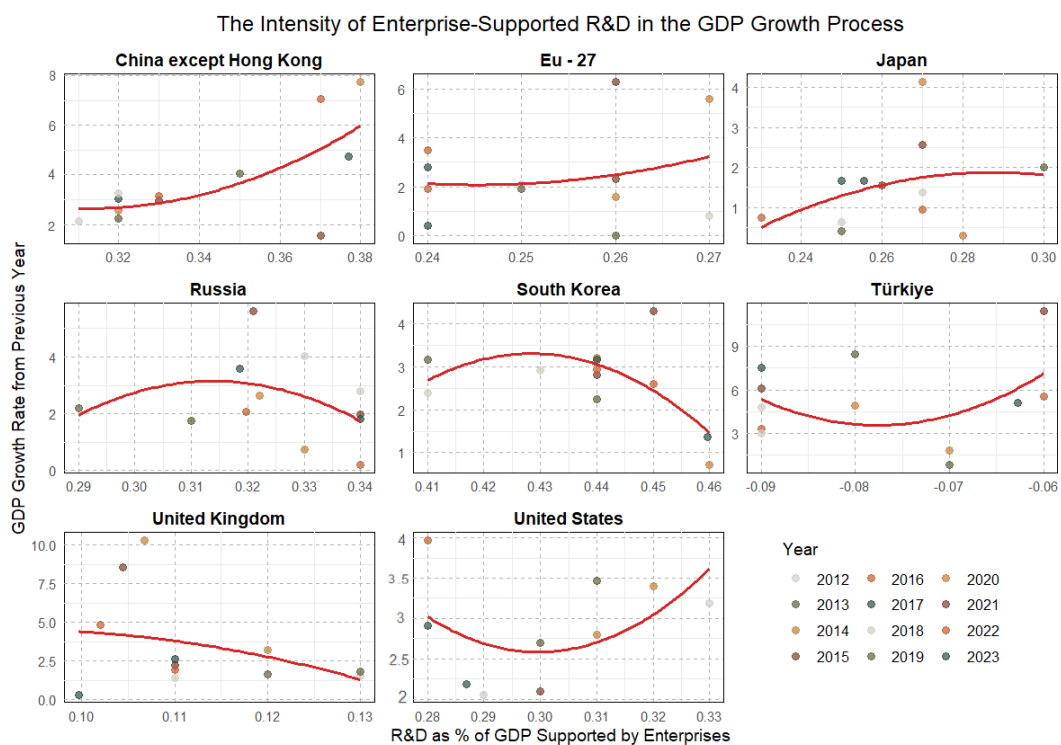


**Source:** author's own process of data using RStudio.



The United States of America is a good example of a distinct model in terms of the relationship between government investment in research and development and economic growth characterized by a non-linear trend. The graph highlights the fact that the reported levels of public funding in R&D do not generate a significant impact on GDP, but once government investments reach a certain threshold, the effects on economic growth become visible and accelerated. The report suggests that initial public inventions are not enough to boost innovation and productivity, but once a critical level has been exceeded, the accumulation of knowledge and research infrastructure allows for a more efficient use of the capital invested. The explanation of this phenomenon can be found in two fundamental economic mechanisms. The first is the "Standing on shoulders" effect, according to which at higher levels of public funding, companies benefit from previous research and discoveries, accelerating the innovation process. This effect becomes visible only after sufficient expertise and research infrastructure have been accumulated to enable sustained technological progress. The second mechanism is the "fishing out" effect, according to which initial inventions are used for easy-to-implement discoveries with limited economic impact. Only after these stages are overcome, research advances to more complex innovations that have a transformative effect on the economy (Siliverstovs, 2001).

**Figure 4.** *The Intensity of Enterprise – Supported R&D in the GDP Growth Process*



**Source:** author's own process of data using RStudio.

Compared to other developed economies, the U.S. exhibits a variable elasticity of public investment in R&D to economic growth. Unlike the European Union, where government funding has a relatively constant pact, in the UAE the effects are more dependent on the private sector's ability to capitalize on these investments. The American innovation system relies heavily on private companies, which play a critical role in converting public research into commercial processes and technologies. Thus, government funding in R&D has a limited impact if it is not supported by a public sector and policies favorable to technology transfer. The non-linear relationship in question has important implications for U.S. R&D policies. Government investment in R&D must be maintained in the long term to ensure sustainable economic effects, as the benefits only become visible after a long period of knowledge accumulation. At the same time, the effectiveness of these investments depends on the existence of a private ecosystem capable of integrating and commercializing research results. In the absence of clear mechanisms for collaboration between the public and private sectors, government inventions risk being left without a significant economic impact. At the same time, tax regulations and incentives play a crucial role in optimizing this process, facilitating companies' access to financing and promoting a crucial role in optimizing this process, facilitating companies' access to establishment and promoting partnerships between research institutions and the business environment.

Private investment in R&D has a clearer and more positive effect on GDP growth, as it is geared towards the rapid development of products and technologies that bring a competitive advantage to the market. Companies invest in R&D with the aim of creating products and improving production processes, which leads to increased productivity and consistent measurable economic growth. For example, Sylwester's analysis shows that in large encomitants such as those that are part of the G7 group, private investment in R&D is directly associated with economic growth (IDEEA 9). In economies such as China and South Korea, private inventions have facilitated rapid adoption of new technologies. The study by Xu and SIM highlights that specific financial factors such as cash reserves and debt maturity contribute positively to R&D intensity in companies, which is subsequently reflected in significant economic growth. Government-funded R&D focuses on fundamental research and long-term projects, with benefits that materialise gradually and have asocial added value, but which do not immediately translate into GDP growth. On the other hand, private investment is directed towards applied innovations, with rapid effects on productivity and competitiveness, which explains the upward regression line observed in the graphs in Figure 4 – Enterprise Supported R&D.

In Russia, data show that private investment in R&D has an initial positive impact on GDP growth, but subsequently the decline in such investment correlates with a reduction in the stimulus effect on the economy. In addition, government investment in R&D in Russia forms a bell-like curve indicating the existence of an optimal threshold. Allocations below or above the threshold do not bring additional benefits, signaling a limited effectiveness of public policies to support innovation (Shah, 2024).

On the other hand, in Turkey, institutional factors play a decisive role in how investment in R&D influences economic growth. Studies in emerging markets highlight that the institutional environment, through aspects such as political stability, government efficiency and corruption, can shape the relationship between R&D and GDP growth, leading to a different dynamic than in Russia (Kim et al., 2020).

Thus, while Russia faces a variable efficiency of R&D depending on the source of financing, Turkey presents a model in which the institutional context significantly influences the relationship between R&D investment and economic growth. These findings suggest that for effective innovation policies it is essential to adapt funding strategies to the specificities of each institutional environment.

For China and South Korea, private investment in R&D has a significant impact on GDP growth. Studies so much so that, as private companies allocate more and more resources to innovation and technological development, a multiplier effect on economic productivity is generated. Thus, the regression line obtained from empirical analyses is tangentially ascending, sometimes with small deviations depending on the strategy and financial conditions at that time. The positive effects are due to the fact that, in both economies, companies use innovation as the main source of competitive advantage, which leads to the rapid adoption of new technologies and the improvement of production processes. For example, the study conducted by Xu and Sim (2018) highlights that in the manufacturing industry of China and South Korea, private investment in R&D drives notable increases in firms' performance, which subsequently translates into accelerated GDP growth. Thus, for China and South Korea a clearly positive correlation can be observed, where the expansion of private investment in technology and innovation stimulates economic growth by increasing productivity and improving competitiveness in the market.

In Japan, there is a close relationship between R&D expenditure and GDP growth, suggesting that, despite significant investment, the marginal effect of this expenditure on economic growth is small. Studies show that at very high levels of R&D spending, the additional effect of investments becomes smaller and smaller, due to diminishing marginal returns. In Japan, where spending on innovation is already very high, it does not bring a proportionate increase in GDP (IDEA 5). Japan is facing a steep aging population and a shrinking workforce, which can reduce the ability to turn technological innovation into economic growth. These demographic factors limit the rapid adoption of new technologies and affect productivity in the long term, offsetting the positive effects of investment in R&D (IDEA 9). The Japanese economy, characterized by an advanced technological level and a well-developed industrial infrastructure, has reached a ceiling of additional benefits from investments in innovation. Thus, although R&D is continuous, its impact on GDP growth becomes insignificant, compared to emerging economies that can benefit from higher growth through the adoption of new technologies.

In summary, the near-flat curve observed in the graphs of the impact of R&D on GDP in Japan indicates that, beyond a certain level of investment, additional spending on

innovation does not automatically translate into significant economic growth. This is likely the result of a combination of saturation of investment effects, demographic challenges and a mature economic structure, which together mitigate the marginal effects of R&D.

## 5. Conclusion

Investment in research and development is undeniably essential for economic growth, but its impact varies considerably depending on the source of funding and the context of each economy. In both the private and government sectors, they play a crucial role, but their effectiveness is influenced by factors such as the intentional structure, the level of economic development and the policies supporting innovation.

First, the private sector is the main driver of innovation in developed and emerging economies. Companies invest in R&D to remain competitive, introduce new technologies and increase productivity. Data shows that countries such as China and South Korea benefit significantly from private investment, with a strongly positive correlation between private R&D and GDP. This can be explained by investment saturation, demographic challenges and a mature economic structure, which reduce marginal returns on innovation. However, public investment is vital for the development of strategic sectors such as health, infrastructure and emerging technologies, providing a stable framework for long-term innovation.

Another important aspect is the difference between the way R&D is financed in different economies. For example, Russia relies more on government investment, which limits the positive impact on economic growth because the private sector does not contribute enough to innovation. Instead, South Korea has built a hybrid mode, combining government support with a strong involvement of private companies, which has allowed the development of cutting-edge industries, such as technology and biotechnology.

Turkey and the United Kingdom show weaker correlations between R&D and GDP, suggesting that investment is not sufficiently targeted or that innovation is not the main driver of economic growth. In Turkey, for example, public investment is higher than private investment, but the impact on the economy remains limited, indicating problems in the effectiveness of innovation policies. In the United Kingdom, both the private and public sectors have low levels of investment in R&D, reflecting an economic orientation based on services and financing rather than technological innovation.

The United States of America is a special case in the analysis of the impact of investments in research and development on economic growth. The American model is based on the dominance of the private sector, where companies are primarily responsible for innovation. The data shows that the US has one of the highest correlations between private investment in R&D and GDP, confirming that innovation is a key driver of economic competitiveness. Unlike other economies, where government plays a more active role, in the U.S. public

investment is lower and the private sector is encouraged to take the lead. A distinctive aspect of the American economy is its ability to turn research into viable commercial solutions. The US has a well-developed ecosystem of partnerships between universities, research institutes and the private sector, which accelerates the innovation process. This interaction is supported by a favorable tax policy, incentivized for companies and a competitive business environment. However, the US is not without its challenges. Unlike in the European Union, where government funding in R&D is relatively constant and distribution strategically, in the US the effects are more dependent on the ability of the private sector to capitalize on these investments. This model can lead to fluctuations in innovation, as companies are oriented towards short-term profit, and areas that require long-term investment, such as public health or fundamental research, may receive less attention from the private sector.

In conclusion, the impact of R&D on economic growth depends on the balance between public and private financing, the institutional framework and the capacity of each economy to capitalize on innovation. Countries that have managed to create an ecosystem conducive to research and development, such as South Korea and China, have achieved remarkable results. On the other hand, economies that do not have a coherent strategy to support R&D risk not reaping the full benefits of innovation. This analysis suggests that a balanced approach tailored to the national context is key to making research investment a sustained engine of economic growth.

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## Improving human development in West African countries: do cryptocurrencies matter?

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**Abstract.** *This study examines the relationship between cryptocurrencies and human development. To analyze data from nine West African countries between 2016 and 2023, we used the generalized method of moments (GMM) in the system to assess the impact of the trading volume of all cryptocurrencies and the value of Bitcoin and Ethereum on the human development index (HDI). Our results show a positive and significant link between these indicators and the HDI, even after applying the Newey–West and Driscoll-Kraay standard error robustness tests. In light of these results, we recommend that policymakers establish a clear and appropriate regulatory framework while being vigilant to the risks inherent in cryptocurrencies.*

**Keywords:** blockchain technology, cryptocurrencies, Bitcoin, Ethereum, IDH.

**JEL Classification:** E42, G21, O15.

## 1. Introduction

Cryptocurrencies are a new form of electronic money based on blockchain technology. This technology enables secure and transparent transactions without the need for a trusted third party (Nakamoto, 2008). The blockchain is a decentralized digital ledger that securely and immutably records transactions, grouped into "blocks" linked together via cryptographic techniques (Tripathi et al., 2023). Bitcoin was the first cryptocurrency to offer an innovative concept of decentralized electronic money. Since its launch in February 2009, many cryptocurrencies have emerged, each with specific characteristics (Agu, 2020). The cryptocurrency industry has grown considerably, with the emergence of new currencies and an increase in the value of older currencies (Kamau, 2022). However, Bitcoin and Ethereum remain the two most dominant cryptocurrencies, accounting for more than 70% of the market's total market capitalization (CoinMarketCap, 2024).

The potential of blockchain technology and cryptocurrencies is attracting increasing interest from businesses and governments alike. Indeed, blockchain is of particular interest in traditional sectors of the economy because of its wide range of applications, well beyond its initial use, and its ability to foster a more inclusive society and a transparent and accountable digital economy (Maupin, 2017). Cryptocurrencies are rapidly transforming markets and societies, decentralizing interactions between consumers, businesses and policymakers (Desmond et al., 2019). People adapt digitally and create new business practices in response to changing economic needs (Morkunas et al., 2019; Yun et al., 2016). Today, cryptocurrencies are gaining mainstream acceptance, with many people using them to make online payments, invest in or diversify their wallets. This growing adoption has led to an increase in the popularity of crypto assets since 2017 (Joebges et al., 2024).

The use of this new technology could play a crucial role in the socioeconomic development of developing countries. Indeed, the introduction of new technologies can have a significant effect on improving living conditions in these countries (Schmidt & Sandner, 2017). Blockchain, in particular, offers promising solutions to many of the challenges faced by developing countries (Swan, 2015), and West Africa, with its immense cryptocurrency potential, could take full advantage. This region, characterized by a young population and growing internet penetration, is particularly conducive to cryptocurrency adoption. Between 2010 and 2017, the number of mobile subscribers in West Africa doubled, with a compound annual growth rate (CAGR) of 9.5% (GSMA, 2019). In addition, many countries in the region have limited financial infrastructures, making cryptocurrencies particularly attractive as alternatives to traditional financial services. The high concentration of banking in urban areas, to the detriment of rural and peripheral areas, as well as the difficulties in accessing financial services for the most vulnerable populations, reinforce this appeal (Avom & Bobbo, 2018). Finally, the economic challenges facing West Africa, such as inflation, corruption and currency instability, make cryptocurrencies attractive as a means of preserving the value of money. Given the current context, further research into the socioeconomic implications of cryptocurrencies in this region is essential.



This study aims to examine how the use of cryptocurrencies can potentially improve the human development index (HDI) in West African countries. This work contributes to the literature in several ways. First, this study is, to our knowledge, one of the first to thoroughly examine the effects of cryptocurrencies on the HDI in the specific context of West African countries. Second, despite the vast literature on cryptocurrencies, few studies have addressed the effects of these digital assets from a human development perspective. Most existing studies have focused on more technical or financial aspects, such as the effects of cryptocurrencies on energy consumption (Schinckus et al., 2020), market volatility (Uzonwanne, 2021), their role as safe havens (Jeribi et al., 2021), the threats they pose to financial stability (Panigrahi, 2023), or the critical evaluation of cryptographic innovations (Shin & Rice, 2022). Finally, this research uses robust econometric methods to ensure the reliability of the results.

The rest of the study is structured as follows: the second section presents a review of the literature, the third section details the methodology employed and the data used, the fourth section presents the results and their discussion, and finally, the fifth section concludes the study and proposes policy implications.

## 2. Literature review

### 2.1. Cryptocurrency: Concepts and evolution

In view of the remarkable development of cryptocurrencies, it seems pertinent to clarify the concept of cryptocurrency and analyze its evolution. The term "cryptocurrency" refers to a decentralized digital currency secured by cryptographic techniques such as the blockchain (Chey, 2023). This technology has enabled communities to emerge around shared values and interests, fostering the emergence of new, more sustainable and responsible forms of social relations (Shin & Rice, 2022). Today, the number of cryptocurrencies continues to grow, and some cryptocurrencies are now recognized by governments and accepted by major corporations (Fang et al., 2022).

Historically, cryptocurrencies date back to 2009 with the invention of Bitcoin, in the wake of the global financial crisis, by a person or group of people using the pseudonym Satoshi Nakamoto. It is a "peer-to-peer electronic payment system", whereby online payments can be sent directly from one party to another, without the intermediary of a central body, via blockchain technology (Nakamoto, 2008). The blockchain concept was introduced as the foundation of bitcoin cryptocurrency, a new electronic money system that relies on no trusted third party. Since then, many other cryptocurrencies have emerged, such as Ripple, Litecoin, Monero and Ethereum. Today, the cryptocurrency market is growing rapidly, attracting the attention of investors worldwide.

The most striking attribute of cryptocurrencies, which sets them apart from traditional currencies, is their decentralized nature. Unlike traditional centralized financial systems, which rely on a central authority (such as a central bank), cryptocurrencies operate on

decentralized networks, where no single individual or entity controls the entire system. This decentralization significantly reduces the risks associated with manipulation by a central authority and offers users a greater degree of control over their transactions (Chey, 2023).

## **2.2. Instability and risks associated with cryptocurrencies**

In addition to the spectacular growth in the popularity of cryptocurrencies, the market for these digital assets is characterized by high volatility. Cryptocurrency prices fluctuate considerably in a very short space of time, making their use as a medium of exchange, unit of account or store of value complex. As a result, they are often perceived as speculative assets, particularly attractive to investors in search of quick gains.

Bitcoin, the first cryptocurrency created, is a perfect illustration of this volatility. After peaking at \$69,000 in November 2021, it lost almost half its value in just a few months, stabilizing at approximately \$35,000. This trend continued with further significant fluctuations, reaching \$47,000 in February 2022, before dropping to less than \$20,000 in June of the same year (Chey, 2023). Giudici et al. (2020) noted that investors in the cryptocurrency market are mainly individuals and that the fundamental value of these assets remains difficult to assess. In addition, the authors highlight the high risk associated with these investments. Fantazzini and Zimin (2020) confirm this analysis, showing that the price of a cryptocurrency can collapse due to events such as scams or hacks, leading to a loss of liquidity and a significant depreciation in the asset's value.

## **2.3. Cryptocurrency and human development**

There is no clear consensus on the socioeconomic effects of cryptocurrencies. Although a great deal of research has been devoted to cryptocurrencies and associated variables over the past decade, studies specifically focusing on their impact on human development are relatively recent, and their conclusions are divergent. For example, Ebelogu et al. (2019) conducted a qualitative study exploring how cryptocurrencies could be used as tools to stimulate the Nigerian economy. The authors suggest that cryptocurrencies could eventually replace fiat currencies and contribute to the country's economic development. Similarly, Miśkiewicz et al. (2022) reported that cryptocurrency trading has stimulated economic growth, attracting investment in innovative and environmentally friendly technologies, which could help reduce the carbon footprint associated with this growth.

According to Chuen et al. (2018), economic growth and value creation can be stimulated by digital financial systems such as cryptocurrencies and regulated exchanges. Jati et al. (2022) confirm this idea by demonstrating that the stock market, financial innovation and cryptocurrencies are positively correlated with long-term economic growth in Indonesia.

According to Leonard and Treiblmaier (2019), cryptocurrencies could become a key driver of economic growth. Indeed, they are gradually becoming part of everyday life in both developed and developing countries, reshaping economic landscapes and stimulating trade, transactions and financial activities. In so doing, they contribute to economic growth and greater financial inclusion (Jaja et al., 2023). These new forms of currency have opened up

investment opportunities for millions of people and facilitated international money transfers while also offering new savings options. The potential of cryptocurrencies is immense, and their adoption is accelerating, promising sustained economic growth and more inclusive development.

Hazard et al. (2016) highlighted that digital currencies contribute to economic growth by reducing transaction costs. This conclusion is corroborated by Aiello et al. (2023), who highlighted the significant impacts of cryptocurrencies on the real economy, notably by stimulating consumption and investment. From a corporate perspective, wider and easier access to credit encourages entrepreneurship and the emergence of new businesses in the market (Klapper & Love, 2004). On a macroeconomic scale, an inclusive financial system, facilitated by cryptocurrencies, enables more resources to be mobilized for investment, particularly in SMEs (Kim et al., 2018). This strengthens a country's financial stability and reduces the risk of poverty (Morduch & Haley, 2002), as cryptocurrencies offer an alternative to traditional banking systems and enable wider access to decentralized financial services.

More recently, Astini et al. (2023) explored the links between cryptocurrency trading, environmental degradation, economic growth and energy consumption in the top 10 Asian economies between 2012 and 2020. The authors used the ARDL method and Granger causality test to analyze these relationships. Their results revealed a bidirectional association between cryptocurrency trading and carbon emissions on the one hand and energy consumption on the other hand. They also reported a causal relationship running from cryptocurrency trading to economic growth and from carbon emissions to economic growth. The authors conclude that strong growth in cryptocurrency trading boosts economic growth as measured by GDP. These results are in line with those of Miśkiewicz et al. (2022) and Mohsin et al. (2023).

Despite the advantages of cryptocurrencies, they also present disadvantages for economies (Agu, 2020). Using panel data from developing countries between 2010 and 2017, Sadraoui et al. (2021) reported a positive correlation between exchange rates and bitcoin prices but a negative and significant relationship between the bitcoin price and financial openness. According to Hunter and Kerr (2019), bitcoin could complicate monetary policies and limit the development of a stable economy. Conlon et al. (2020) argue that cryptocurrencies are not safe havens for economic growth and stock markets. Abdeldayem and Aldulaimi (2020), meanwhile, consider cryptocurrency investments to be riskier than those made on the stock market. The work of Bojaj et al. (2022), meanwhile, has highlighted an acceleration in economic growth owing to bitcoin. However, shocks to the cryptocurrency market can influence investment decisions, disrupt traditional markets and worsen macroeconomic indicators.

This literature review highlights the lack of in-depth analysis of the contribution of cryptocurrencies to human development in Africa, particularly in West African countries. We propose to fill this gap by examining how cryptocurrencies can help West African economies take full advantage of the opportunities offered by this new technology.

### 3. Analysis methodology and presentation of data used

#### 3.1. Methodology

The aim of this study is to examine the impact of cryptocurrencies on the human development index. To do so, the study relies on the following estimation model, inspired by Matekenya et al. (2021). The relationship is expressed as

$$HDI_{it} = F(FINCLU_{it}, X_{it}) \quad (1)$$

where  $IDHi$  represents the human development index,  $FINCLU_i$  represents financial inclusion and  $X_i$  represents a set of control variables. The index  $i$  represents the  $i$ th country. Unlike the work of Matekenya et al. (2021), this article replaces financial inclusion with cryptocurrencies.

The estimable form of equation (1) is specified in equation (2) as follows:

$$HDI_{it} = \delta_1 + \delta_2 HDI_{i(t-1)} + \delta_3 TRADE_{it} + \delta_4 \log ACCEL_{it} + \delta_5 SPEND_{it} + \delta_6 INF_{it} + \delta_7 DEBT_{it} + \delta_8 UN_{it} + \delta_9 Credit_{it} + \delta_{10} \log Crypto_{it} + \varepsilon_{it} \quad (2)$$

where  $i$  and  $t$  represent countries and time (years), respectively,  $\varepsilon$  is the error term,  $\delta_i$  ( $\delta_1 - \delta_{10}$ ) are parameters or coefficients to be estimated, and  $\log$  is logarithmic notation. The rest of the terms are described below.

HDI refers to the human development index used to capture the level of human development (Nguea, 2023). Indeed, the ranking of nations according to the HDI has enriched the debate on human development, and the HDI is now used as a composite indicator for measuring development. A nation's development is now measured not only in terms of per capita income but also in terms of health and education outcomes. The more conventional HDI is an index measuring the quality of life of populations, with values ranging from 0-1, and is based on three distinct components: (i) longevity, measured by life expectancy at birth. It reflects the capacity of populations to lead long, healthy lives. (ii) Education, represented by a weighted average of literacy and school enrollment rates. It is an approximation of the capacity of individuals to acquire knowledge, train and inform, and participate in community life. (iii) Standard of living, represented by real per capita income (GDP/head) adjusted for purchasing power. It represents people's access to the resources they need to improve their quality of life.

Crypto here refers to cryptocurrency-related metrics, namely, the total market capitalization volume of all cryptocurrencies active on exchange platforms, the change in value of Bitcoin (the leading cryptocurrency in terms of market dominance), and the change in value of Ethereum (the second-largest cryptocurrency in terms of market dominance). These two cryptocurrencies remain the world's largest in terms of market capitalization and price (Hicks, 2023).

Concerning the control variables, TRADE represents trade openness, ACCEL represents the percentage of the urban population with access to electricity, SPEND represents the

share of expenditure devoted to consumption as a percentage of GDP, Inf represents the inflation rate, DEBT represents external debt as a percentage of GDP, UN represents the unemployment rate, INF is inflation, and Crédit represents the share of domestic credit granted to the private sector.

### 3.2. Data

This article aims to examine the effect of cryptocurrencies on the HDI. Our study focuses on the West African region, covering the nine main countries in the region that use cryptocurrencies: Nigeria, Ghana, Ivory Coast, Togo, Mali, Benin, Senegal, Burkina Faso and Cape Verde. We used secondary data covering the period from 2016-2023 from sources including the World Bank.

(WDI), the United Nations Development Program (UNDP) and CoinMarketCap.

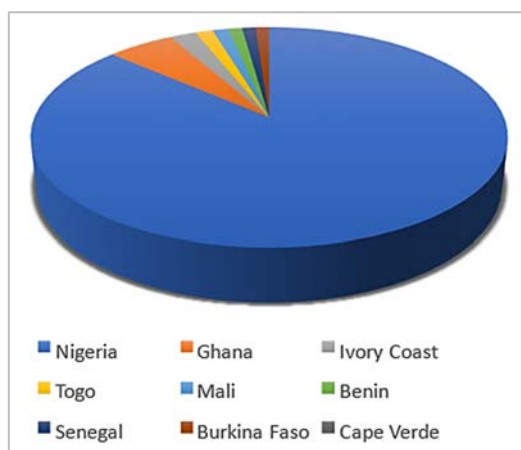
## 4. Results presentation and discussion

This section is divided into three parts. The first presents the results of the study. The second section discusses the results obtained via the generalized method of moments-system (GMM-System). Finally, the third part analyzes the robustness of the results via the standard error methods of Driscoll and Kraay (1998) and Newey and West (1987).

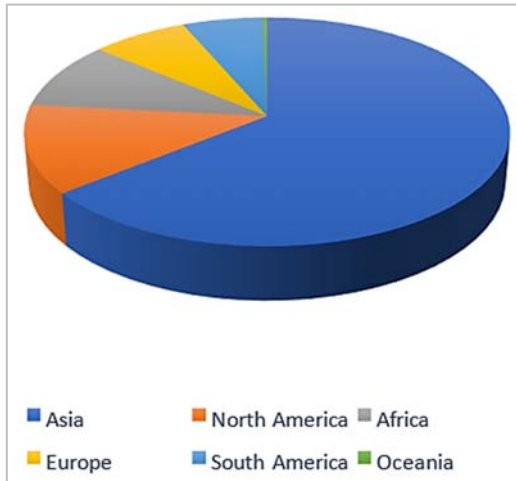
### 4.1. Presentation of results

An analysis of Figure 1 reveals that Nigeria is the West African country with the largest number of cryptocurrency holders. In 2022, with 22.33 million holders (or 10.34% of its population), Nigeria accounted for a significant share of the 55 million cryptocurrency holders counted in Africa (Vedie, 2022).

**Figure 1.** Ranking of the main holding countries cryptocurrencies West Africa in 2022



Source: Author.

**Figure 2.** Continental ranking in terms of cryptocurrencies in 2022

Source: Author.

In contrast, Figure 2 highlights the dominance of Asia, which boasts the largest number of cryptocurrency holders in the world, far ahead of the other continents. Oceania, meanwhile, boasts the lowest adoption rate.

**Table 1.** Descriptive statistics

Variables	Moy	Er.type	Min	Max
Inequality-adjusted human development index	0.423	0.051	0.319	0.512
Trade openness	32.980	13.246	2.684	60
Access to electricity	84.490	12.658	51.700	99.700
Consumer spending	1.930	0.031	1.849	2.008
Inflation	5.178	7.701	-3.230	38.110
External debt	3.929	3.895	0.369	19.490
Unemployment rate	3.462	1.963	0.690	7.292
Domestic credit to the private sector	26.080	13.187	9.963	68.460
Cryptocurrency market capitalization	11.340	0.915	9.746	12.270
Bitcoin value	4.104	0.548	2.915	4.732
Ethereum value	2.908	0.522	2.110	3.534

Source: Author.

Table 1 shows the descriptive statistics for the variables used in the model. Table 2 shows the correlation matrix between these variables, enabling us to assess the existence of linear links between them. Notably, all cryptocurrency metrics are positively correlated with the human development index (HDI). However, this correlation, although positive, is not strong enough to generate a significant multicollinearity problem, as the correlation coefficients are all less than 0.8. According to Kennedy (1985), a correlation coefficient greater than 0.8 between two explanatory variables may indicate a multicollinearity problem, requiring specific tests. The significance of these correlations will be examined in greater detail in the GMM-system analysis.

**Table 2.** Correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) HDI	1										
(2) TRADE	-0.169	1									
(3) ACCEL	-0.016	0.206	1								
(4) SPEND	-0.150	0.065	0.170	1							
(5) INF	0.144	-0.391	0.230	0.171	1						
(6) DEBT	-0.281	0.109	-0.300	-0.271	-0.070	1					
(7) UN	-0.264	-0.010	0.580	0.359	0.152	-0.340	1				
(8) Credit	-0.374	0.760	0.220	0.255	-0.412	0.002	-0.047	1			
(9) LogCapiboursm	0.179	0.028	0.220	-0.019	0.214	0.031	-0.041	0.018	1		
(10) LogVBitcoin	0.170	-0.003	0.210	-0.002	0.250	0.006	-0.056	0.049	0.610	1	
(11) LogVethereum	0.173	-0.001	0.230	-0.007	0.258	0.019	-0.060	0.051	0.600	0.940	1

Source: Author.

**Table 3.** Effects of cryptocurrencies on human development based on system-GMM estimates

Variables	HDI		
	(1)	(2)	(3)
Lagging human development index (-1)	-0.538*** (0.134)	-0.572*** (0.133)	-0.563*** (0.129)
Trade openness	0.002*** (0.000)	0.002*** (0.000)	0.002** (0.000)
Access to electricity	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Consumer spending	0.340*** (0.102)	0.330*** (0.098)	0.347*** (0.105)
Inflation	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
External debt	-0.003** (0.001)	-0.003*** (0.001)	-0.003** (0.001)
Unemployment	-0.015*** (0.001)	-0.015*** (0.001)	-0.015*** (0.001)
Domestic credit to the private sector	-0.004*** (0.000)	-0.004*** (0.000)	-0.004*** (0.000)
Total cryptocurrency market capitalization (log)	0.010*** (0.002)		
Bitcoin value (log)		0.022*** (0.004)	
Ethereum value (log)			0.023*** (0.005)
Constant	-0.094 (0.227)	-0.010 (0.229)	-0.027 (0.227)
Wald $\chi^2$	707.33	1587.80	4269.62
Prob $>\chi^2$	0.000	0.000	0.000
AR (1) (p value)	0.008	0.008	0.009
AR (2) (p value)	0.357	0.384	0.427
Hansen test (p value)	0.197	0.213	0.216
Observations	64	64	64
Number of countries	9	9	9

Source: Author.

## 4.2. Discussion of results

This section presents the empirical results of the study. Table 3, which reports the results of the generalized method of moments system (GMM system) estimation, presents the coefficients of the variables as well as the diagnostic test statistics. These results satisfy the various assumptions of the GMM model, and the Wald statistic is highly significant, confirming the overall quality of the model. Furthermore, the probabilities of the AR

autocorrelation test (1) are all less than 1%, whereas those of the AR autocorrelation test (2) are greater than 10%. On the other hand, the probabilities of the Hansen test are all above 10%, confirming the absence of instrument overidentification and serial correlation. The instruments used in the estimations are therefore valid. These encouraging results allow a thorough analysis of the effects of the different variables on the dependent variable.

The results of the econometric estimations show that the coefficient of the lag term of the human development index (HDI) is negative in all the models, suggesting a process of convergence toward a common stationary state in human development. This means that West African countries with a low initial HDI tend to grow faster than those with a high initial HDI.

The results show that the impact of cryptocurrencies on the HDI is significantly positive at the 1% threshold in all the models estimated. Specifically, an increase in total cryptocurrency market capitalization, the Bitcoin price and the Ethereum price is associated with an improvement in the HDI. These results are in line with the findings of Kim et al. (2018) and Morduch and Haley (2002), who demonstrated that an inclusive financial system promotes greater availability of resources for investment, particularly in SMEs. This result could be explained by the fact that cryptocurrencies can stimulate human development through several channels. Indeed, they can play a crucial role in financial inclusion by offering decentralized financial services to unbanked populations, strengthening their financial autonomy and enabling them to manage their funds more independently. Moreover, cryptocurrencies can give citizens direct control over their funds without financial intermediaries. Furthermore, providing financial services to disadvantaged individuals and communities can promote access to quality education and health services, which are essential for human development. Finally, cryptocurrencies can facilitate international transactions by reducing the costs and delays associated with money transfers, thus stimulating trade and economic cooperation between different regions of the world.

The effect of trade openness on human development is positive and highly significant. The results indicate that an increase in trade openness improves the HDI. Indeed, trade openness can contribute to improving human development by promoting economic growth, creating jobs, increasing people's incomes and improving access to new products and services in markets, which can significantly increase citizens' well-being and quality of life. In terms of consumer spending as a percentage of GDP, the results show a strong positive effect of consumption on the human development index, with a statistically significant coefficient at the 1% level. Thus, an overall increase in consumer spending is associated with a higher human development index. Indeed, spending on goods and services could promote the well-being of citizens by contributing to the satisfaction of basic social needs, the improvement of individual health and physical well-being, the creation of happiness, and the stimulation of the economy in general. On the other hand, the results reveal that external debt has a negative relationship with the level of human development. An increase in external debt leads to a decrease in the HDI. Indeed, a very high level of debt could limit



investment in key sectors of the economy, such as education, health and social services, exacerbating economic disparities and inducing financial instability, thus failing to promote inclusive and equitable human development. The results are in line with those of Adeve and Karabou (2022), who also reported a negative and significant relationship between public debt and the sustainability of development in the economies of the countries of the West African Economic and Monetary Union (WAEMU). Similarly, the effect of unemployment on human development is negative and statistically significant in all estimations. An increase in unemployment leads to a decrease in the HDI. Indeed, a very high level of unemployment can exacerbate poverty, which can have adverse effects on people's well-being by reducing their quality of life. These results are in line with the work of Datta and Singh (2019), who argued that the lower the level of poverty is, the higher the level of human development. Finally, domestic credit to the private sector also has a negative and statistically significant effect on human development in all specifications. An increase in domestic credit to the private sector leads to a decrease in the HDI. This is explained by the fact that excessive domestic credit can lead to an increase in the general price level of goods and services, which can reduce consumers' purchasing power and negatively affect their living conditions.

### 4.3. Robustness analysis

Table 4 presents the robustness results for the effects of cryptocurrencies on the HDI, obtained via the techniques of Newey and West (1987) and Driscoll and Kraay (1998).

**Table 4.** Robustness analysis using Newey–West and Driscoll–Kraay standard errors

Variables	Newey–West			Dscoll–Kraay		
	1	2	3	4	5	6
Trade openness	0.001*** (0.0002)	0.001*** (0.0002)	0.001*** (0.0002)	0.001*** (0.0002)	0.001*** (0.0002)	0.001*** (0.0001)
Access to electricity	0.255*** (0.075)	0.244*** (0.076)	0.250*** (0.074)	0.255*** (0.059)	0.244*** (0.058)	0.250*** (0.061)
Consumer spending	0.220* (0.126)	0.218* (0.126)	0.225* (0.124)	0.220 (0.246)	0.218 (0.249)	0.225 (0.242)
Inflation	-0.0008 (0.0004)	-0.0007 (0.0004)	-0.0008* (0.0004)	-0.0008 (0.0006)	-0.0007 (0.0006)	-0.0008 (0.0006)
External debt	-0.005*** (0.0010)	-0.005*** (0.0009)	-0.005*** (0.0009)	-0.005*** (0.001)	-0.005*** (0.001)	-0.005*** (0.001)
Unemployment	-0.018*** (0.003)	-0.018*** (0.003)	-0.018*** (0.003)	-0.018*** (0.003)	-0.018*** (0.003)	-0.018*** (0.003)
Domestic credit to the private sector	-0.003*** (0.0004)	-0.003*** (0.0004)	-0.003*** (0.0004)	-0.003*** (0.0003)	-0.003*** (0.0003)	-0.003*** (0.0003)
Total cryptocurrency market capitalization (log)	0.006* (0.003)			0.006** (0.002)		
Bitcoin value (log)		0.012** (0.005)			0.012* (0.005)	
Ethereum value (log)			0.013** (0.005)			0.013** (0.005)
Constant	-0.442*** (0.288)	-0.397 (0.289)	-0.408 (0.281)	-0.442 (0.396)	-0.397 (0.411)	-0.408 (0.396)
R-squared				0.544	0.547	0.548
p value	0.000	0.000	0.000	0.000	0.000	0.000
Observations	72	72	72	72	72	72

Source: author

Overall, the results in Table 4 confirm those in Table 3. The effects of cryptocurrencies on human development remain positive and statistically significant. An increase in cryptocurrency trading volume, measured by total market capitalization, Bitcoin and Ethereum value, is associated with improved human development in West African countries. Furthermore, the results underline the importance of trade openness, access to electricity and consumer spending for human development. Conversely, inflation, the stock of external debt, unemployment and credit to the private sector have negative effects on the HDI. Rising inflation, coupled with high indebtedness, high unemployment and excessive domestic credit, worsens the well-being of populations.

## 5. Conclusion and policy implications

The Human Development Index (HDI) classifies sub-Saharan African countries as "low human development countries". These countries have significantly lower levels of human development than other regions of the world do. Despite sustained economic growth since the 2000s, particularly in West Africa, the region continues to face persistent challenges such as poverty, unemployment and inequality. By democratizing access to new blockchain technologies, cryptocurrencies could provide a major lever for improving people's living conditions.

This study assessed the impact of cryptocurrencies, measured by their total market capitalization, the value of Bitcoin and Ethereum, on the human development index (HDI) in the nine main West African countries using these digital assets. The data analyzed cover the period from 2016-2023. Using an in-system generalized method of moments (GMM) estimation approach, our results highlight a positive association between cryptocurrencies and human development. Furthermore, we find a positive relationship between trade openness and human development, on the one hand, and between consumer spending as a percentage of GDP and human development, on the other hand. Conversely, foreign debt, unemployment and credit to the private sector have a negative influence on the HDI.

In view of these findings, this study suggests that African policymakers should establish a clear regulatory framework conducive to the development of cryptocurrencies while ensuring consumer protection against the risks inherent in their volatility. Investment in digital infrastructure, particularly in rural areas, is essential to foster the adoption of cryptocurrencies. In addition, public authorities should encourage startups and innovative initiatives in this field to stimulate the emergence of solutions tailored to local specificities. These recommendations could accelerate the adoption of cryptocurrencies in Africa and thus contribute to improving people's standard of living.

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## Romanian knowledge and attitude on sustainability and sustainable clothing: exploring the reliability and validity of a measurement scale

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**Abstract.** *Sustainability is crucial in balancing environmental conservation and economic growth. However, consumer knowledge and attitudes towards sustainable clothing are underexplored. This study aims to contribute to the existing literature by exploring a measurement scale, the Sustainable Clothing Measurement Scale (SCMS) that evaluates consumers' knowledge and attitudes toward sustainability and sustainable clothing consumption of 1,250 Romanian participants. Statistical methods such as exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) confirm the scale's reliability and validity, with strong internal consistency and significant correlations between the dimensions. This study introduces a new tool beneficial for researchers and practitioners in exploring knowledge and attitudes toward sustainability and sustainable clothing. SCMS has the potential to offer valuable insights destined to enrich consumer behaviour studies, inform policy initiatives, and create educational programs that promote sustainability in the textile industry and other related fields. Future research should continue with improving and further testing this new conceptualized tool.*

**Keywords:** Sustainable Clothing Measurement Scale (SCMS), scale development, sustainability, sustainable clothing consumption.

**JEL Classification:** D12, C20, C10, Q56.

## 1. Introduction

Sustainability has become a significant global challenge over the last two decades. The concept was first brought to discussion with the Brundtland Report “Our Common Future” in 1987 (World Commission on Environment and Development, 1987, p. 43), when sustainability (also referred to as sustainable development) was defined as “development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs”. The Brundtland definition emphasizes a long-term temporal frame, a feature often absent in more commonly used definitions. Sustainability, in its truest sense, demands the ability to maintain its viability indefinitely. The only way for an initiative, policy, or community to sustain itself over time is by refraining from detrimental impacts on the environment, economy, and social welfare. However, the reports’ ambiguous view of sustainability has faced criticism from many scholars, with numerous studies aimed at understanding and predicting this broad and multifaceted field. (Balderjahn et al., 2013; Costanza and Patten, 1995)

Understanding the motivations behind sustainable behaviour is essential for fostering the societal transformations required to prevent environmental, social, and economic crises resulting from natural resource exhaustion and climate change. (Zwickle and Jones, 2018) The broad and multidimensional nature of sustainability, along with its broad appeal across different groups, has motivated scholars from various academic backgrounds to explore it through different theoretical and methodological lenses.

Many attempts have been made to clarify and refine the meaning of sustainability within the business sector. Amid this expansive exploration, there is a rising emphasis on sustainable consumption, which incorporates approaches like green consumption. (Ng et al., 2023; Peattie, 2010), political consumption (Halkier, 2004; Toth et al., 2022), and ethical consumption (Devinney et al., 2010; Karimzadeh and Boström, 2024; Newholm and Shaw, 2007). These approaches tend to centre around specific factors influencing sustainable behaviours and often fall short of addressing the wider perspective of sustainable consumption. (Balderjahn et al., 2013)

Various measurement instruments have been developed to assess the multiple components of sustainability. (Balderjahn et al., 2013; Gilg et al., 2005; Iwata, 2006; Pepper et al., 2009) A significant number of initiatives have contributed to the development of tools for assessing sustainable consumption, (Fischer et al., 2017; Geiger et al., 2018) and awareness. (Balderjahn et al., 2013) Prominent among measurement tools are the Sustainable Apparel Consumption Scales, which cover multiple dimensions of sustainable clothing consumption, including eco-fashion consumption, post-acquisition behaviours, and environmental awareness, (Zhang, 2014) The Sustainable Clothing Consumption Scale is designed to evaluate the cognitive, emotional, and behavioural dimensions when consuming sustainable clothing. (Park and Lee, 2021), and the Sustainable Fashion Awareness Scale focuses on consumer knowledge and awareness of sustainable fashion practices and items. (Shen et al., 2013)

Despite significant advancements, most consumers still engage in unsustainable behaviours. (Wang and Udall, 2023). There is still a gap in assessing individuals’



understanding and attitudes toward sustainability and sustainable clothing choices. This study seeks to resolve the lack of theoretical frameworks that assess both the broader concept of sustainability alongside sustainable clothing consumption. In pursuit of this objective, we designed a robust and reliable measurement tool, the Sustainable Clothing Measurement Scale (SCMS), to assess respondents' attitudes and knowledge concerning sustainability and sustainable clothing consumption. This proposed scale differs from other sustainability and sustainable clothing consumption measures by not emphasizing specific behaviours or scenarios. Instead, it focuses on individuals' broad views of sustainability and their perspectives on sustainable clothing consumption. Furthermore, the instrument seeks to assess respondents' fundamental knowledge and attitudes regarding sustainability in the fashion industry, steering clear of specific subjects and emphasizing elements that enhance the tools' effectiveness.

The Romanian context reveals a considerable research gap related to the existence of a comprehensive assessment tool designed to evaluate consumers' attitudes and knowledge towards sustainability and sustainable clothing consumption. Drawing from the current body of literature on sustainability, sustainable consumption, sustainable clothing consumption, and measurement methods, the study intends to develop a scale suited to the Romanian context that will bridge the gap.

The outcomes of this study expand our comprehension of sustainability and sustainable clothing consumption, providing practical recommendations for fostering sustainable clothing consumption in Romania.

The study is organized as follows: the second section provides a literature review, followed by a section on methodology. The fourth section presents the main findings, while the fifth section discusses the results and their implications. The final section provides conclusions, outlines limitations, and suggests directions for future research.

## 2. Theoretical Basis of SCMS construct

### 2.1. Sustainability and sustainable clothing consumption

From the most frequently used definition, sustainability is often expressed as development that satisfies current needs, while ensuring future generations can meet theirs without compromise. (Kuehl et al., 2023; Purvis et al., 2019) The concept of sustainability addresses three main aspects: the interconnection between humans and the natural environment; the integration of economic, social, and environmental protection goals, and the importance of a global perspective and unified principle. (Shen et al., 2013) From this perspective, sustainability is often divided into three primary pillars: environmental, economic, and social dimensions. The sustainability movement has grown to reflect a persistent engagement with various domains like organic production, green initiatives, fair trade, and unethical business practices. This has led the concept of sustainability to gain a more receptive audience in several consumer-oriented sectors, for all three pillars (economic, social, and environmental).

When compared to the complexities of economic and social sustainability, environmental sustainability is a more straightforward concept since it encompasses maintaining biodiversity, ensuring ecosystem integrity, and carrying capacity. It calls for the preservation of natural capital both as a source of economic resources and as a repository for waste. (Basiago, 1998) To ensure sustainability, natural resource usage implies consuming them at a rate that does not exceed their natural rate of replenishment, while waste emissions must occur at a rate that does not exceed the environment's capacity to assimilate them. In terms of ecosystem health, sustainability can be understood as preserving the landscape's existing or native structure and functions. (Basiago, 1998; Zwickle and Jones, 2018)

The concept of sustainability has also been embraced by the fashion industry. The growing sense of fashion among clothing consumers has led to an increase in consumption and modifications in demand patterns. The fast fashion concept came as a response to their rapidly changing needs and tastes, resulting in concerns regarding the reduction of world reserves and the rising levels of industrial waste. (Saricam et al., 2017) In the context of fashion, sustainability implies ethical production and selling practices that are environmentally responsible, ensure good working conditions, use eco-friendly and recycled materials, and focus on creating long-lasting products, along with eco-certificates. (Fletcher, 2008; Joergens, 2006) Businesses operating in the sustainable fashion sector are focused on attaining recognition, raising awareness among consumers about their products and services, and also stimulating their demands. Marketing efforts focus on emphasizing health concerns and the urge to minimize environmental impact. (Saricam et al., 2017) Despite this, it is uncertain if consumers have a clear understanding of what sustainable clothes and sustainability represent. By exploring consumers' knowledge of sustainable clothing consumption, confusion about the notion of sustainability can be reduced, enlightening the market, and delivering accurate marketing messages that encourage consumers to purchase sustainable clothes.

## **2.2. Sustainable attitudes**

During the past decade, more and more scholars have explored sustainable consumer behaviour and sustainable attitudes, especially regarding sustainable clothing consumption. Studies have shown that consumers are increasingly responsive, with growing awareness and willingness to change their consumption habits and adopt alternative products. However, consumer responses are often regarded as inconsistent or irrational, making it challenging to uncover the underlying reasons for negative attitudes. One justification could be that environmental concerns among consumers do not consistently result in corresponding changes in their purchasing habits. (Henninger and Singh, 2017) In contrast to this, evidence found environmentally friendly attitudes to reflect the likelihood of consumers to either favour or disfavour specific sustainable behaviours, as well as their overall readiness to adopt such behaviours, confirming a direct connection between green attitudes and green behaviour. (Grębosz-Krawczyk and Siuda, 2019; Wiederhold and Martinez, 2018)

Environmentally conscious consumers are often committed to eco-friendly living, make thoughtful product choices, and actively participate in events aimed at environmental

protection. Moreover, social norms play a constant role in influencing consumers, providing guidelines, behavioural principles, and controls for their actions. (Haanpää, 2007; Musova et al., 2021). Despite this, many people continue to view sustainable consumption especially sustainable clothing consumption as an area of uncertainty and unstable attitudes. Thus, there is a need for companies to understand and assess whether their products or services will be successfully perceived and adopted by consumers. For this, it is important to gain insights into consumer sustainable attitudes towards sustainable clothing.

### 3. Research Methodology

From November to December 2023, data was gathered in Romania through an online self-administrated questionnaire shared on various platforms, including Facebook, LinkedIn, WhatsApp, and other social media networks, enabling participants to complete the form. The study sample is based on responses from 1,250 participants who voluntarily and anonymously participated in the survey. Participants gave their consent to take part in the study and were informed about its objectives. The questionnaire applied a mix of convenience sampling, (Baltar and Brunet, 2012) and snowball sampling (Browne, 2005; Heckathorn, 2011) approaches.

#### 3.1. Data collection instruments

To explore sustainable clothing consumption, we initially carried out a thorough literature review on the subjects of sustainability, sustainable clothing, and designing measurement scales for sustainable clothing consumption. Drawing on these insights, we formulated a thirteen-item scale to assess respondents' understanding of sustainability as a broad concept, and their specific awareness of sustainable clothing.

The Sustainable Clothing Measurement Scale (SCMS) focuses on dimensions that include the understanding of sustainability, awareness of sustainable clothing practices, and attitudes regarding sustainable clothing consumption. This scale is designed with elements that emphasize the foundational concepts of sustainability, concentrating on environmental preservation and the conservation of resources. The main objective of the tool is to facilitate the assessment of respondents' knowledge and attitudes toward sustainable clothing. Therefore, items capturing the general notion of sustainability were added, such as "Sustainability means finding a balance between economic growth and environmental protection". Additionally, we included items reflecting attitudes toward sustainability and sustainable clothing, exemplified by the statement "A sustainable attitude means considering the need to protect the planet for current and future generations, while also taking into account economic, environmental, and social factors". Moreover, the SCMS focuses on assessing individuals' knowledge of sustainable clothing, particularly in areas like mitigating agrochemical environmental impacts and sourcing materials in environmentally friendly ways.

The scale items were used as an initial component in a broader study investigating sustainable clothing consumption in Romania. To guarantee accessibility and cultural

suitability, all statements were written in Romanian. All responses were assessed on a seven-point Likert scale, with 1 indicating total disagreement and 7 indicating total agreement. A detailed description of the scale items is found in Table 1, enhancing the transparency and reproducibility of our methodology.

### 3.2. Research Methods

The statistical analysis was carried out using version 4.3.0 of the R software. (R, 2024) We initiated our analysis with a focus on assessing the reliability of the measurement scale, and the correlation matrix, and conducting the adequacy test. We then proceeded with an exploratory factor analysis (EFA) to investigate the construct validity of the scale and explore potential underlying factors within the SCMS dimensions. We conducted the EFA using the ‘psych’ package in R, which includes the required functions, and applied the “varimax” rotation and principal axis extraction method. As indicated in the literature, EFA serves as a crucial step for building a model that can later be validated with confirmatory factor analysis. (Gerbing and Hamilton, 1996) Following the factor extraction, we carried out a confirmatory factor analysis (CFA) to assess the model’s effectiveness, (Schreiber et al., 2006) Using the functions provided by the ‘lavaan’ package in R. (R, 2024)

**Table 1.** Sustainable Clothing Measurement Scale Constructs

Dimension	Items	Abbreviation
Sustainable Clothing Measurement Scale	Sustainability means carrying out activities in a qualitative way that doesn't damage the environment or deplete resources.	SCMS1
	Sustainability means finding a balance between economic growth and environmental protection.	SCMS2
	Sustainability means finding alternative resources while still being able to provide for future generations.	SCMS3
	The principles of sustainability are reduction, reusing, and recycling.	SCMS4
	A sustainable attitude means taking into account the need to preserve the planet for present and future generations, while also considering economic, environmental, and social factors.	SCMS5
	Sustainable fashion means not changing our clothes based on the ongoing trend, but adapting fashion to protect the ecological footprint.	SCMS6
	Sustainable clothing uses fabrics derived from environmentally friendly resources, like sustainably grown fibre crops, or recycled materials.	SCMS7
	Sustainable clothing is special since it is processed in a way that is less harmful to the environment.	SCMS8
	Sustainable clothing reduces the harmful effects of agrochemicals on the environment.	SCMS9
	Using sustainable clothes can help reduce the amount of clothing discarded in landfills.	SCMS10
	Having a sustainable attitude towards clothing often includes buying second-hand clothes.	SCMS11
	Having a sustainable attitude towards clothing means donating or recycling clothes so they can be reused or resold.	SCMS12
	Having a sustainable attitude means owning fewer items but ensuring they are of high quality.	SCMS13

**Source:** Author’s own research.

## 4. Results

The study’s final sample comprises 1,250 participants (77.2% female), with ages ranging from 14 to 77 and an average age of 35.73 (median=35, SD=12.44). Most of the respondents reported a monthly income above 5,000 RON (approximately 1,000 EU), and

77.4% had attained higher education. The results section is organized into three subsections: the first addresses the reliability and consistency of the instrument, the second outlines the exploratory factor analysis results, and the third focuses on the confirmatory factor analysis. This approach was used to provide a more complete overview of the data.

#### 4.1. Reliability and Consistency of the instrument

The analysis commenced with an evaluation of the reliability and homogeneity of our instrument with the help of Cronbach's Alpha, the Kaiser-Meyer-Olkin (KMO) coefficient, and the Bartlett test to ensure the data was appropriate for further investigation. The data is deemed appropriate for factor analysis when the KMO coefficient exceeds 0.60, in combination with a significant Bartlett's test result. (Çelikler and Aksan, 2016) Moreover, the Cronbach's alpha should provide significant results, surpassing the 0.7 threshold. (Cortina, 1993)

Bartlett's test, evaluating the data's stability for factor analysis on our thirteen-item scale, along with the significant statistic chi-square, KMO coefficient, and Cronbach's alpha, collectively confirm that the data is appropriate for further factor analysis. These results are summarized in Table 2.

**Table 2.** Results of the reliability and homogeneity test

Measurement index	Value	
Cronbach's alpha	0.88	
KMO measures of sample adequacy	0.93	
Bartlett's test approximate	1099.1	Df = 12,
Chi-square value		p-value <2.2e-16

**Source:** Author's own research.

#### 4.2. Exploratory Factor Analysis

Upon performing the exploratory factor analysis (EFA), the factors were extracted by applying a 0.4 cut-off point. The factors together explained 51% of the total variance, with individual factors accounting for 21%, 17%, and 13% of the variance, respectively. According to EFA methodology, item factor loadings should be 0.30 or higher. In line with this, research on scale development and adaptation also sets a 0.30 threshold as the minimum acceptable level for item factor loadings in this area of interest. We found that all thirteen items satisfied the required threshold. As such, factor loading is the primary measure for evaluating factor analysis outcomes, representing the correlation between variables and factors. (Çelikler and Aksan, 2016)

The "varimax" rotation technique was employed to assign the items across three distinct factors. (R, 2024) The factor loading values varied between 0.40 and 0.75. The evaluation of the content showed that items were effectively clustered into reliable predictors with strong internal consistency, making it possible to label them according to the latent variables they embodied. We also conducted a Cronbach's Alpha analysis to measure the reliability of each new factor. The scores for the first, second, and third factors were found to be 0.85, 0.84, and 0.66. As a result, the values obtained for these factors showed they were reliable for additional statistical procedures. The SCMS items, along with their latent variable label and reliability scores are shown in Table 3.

**Table 3.** *Sustainable Clothing Measurement Scale Constructs*

Dimension	Items	Factor 1 (0.21)	Factor 2 (0.17)	Factor 3 (0.13)
General Sustainability (0.85)	SCMS1: Sustainability means carrying out activities in a qualitative way that doesn't damage the environment or deplete resources	0.65		
	SCMS2: Sustainability means finding a balance between economic growth and environmental protection.	0.64		
	SCMS3: Sustainability means finding alternative resources while still being able to provide for future generations.	0.66		
	SCMS4: The principles of sustainability are reduction, reusing, and recycling.	0.63		
	SCMS5: A sustainable attitude means taking into account the need to preserve the planet for present and future generations, while also considering economic, environmental, and social factors.	0.64		
Sustainable clothing (0.84)	SCMS6: Sustainable fashion means not changing our clothes based on the ongoing trend, but adapting fashion to protect the ecological footprint.		0.40	
	SCMS7: Sustainable clothing uses fabrics derived from environmentally friendly resources, like sustainably grown fiber crops, or recycled materials.		0.60	
	SCMS8: Sustainable clothing is special since it is processed in a way that is less harmful to the environment.		0.75	
	SCMS9: Sustainable clothing reduces the harmful effects of agrochemicals on the environment.		0.66	
	SCMS10: Using sustainable clothes can help reduce the amount of clothing discarded in landfills.		0.50	
Sustainable attitude (0.66)	SCMS11: Having a sustainable attitude towards clothing often includes buying second-hand clothes.			0.68
	SCMS12: Having a sustainable attitude towards clothing means donating or recycling clothes so they can be reused or resold.			0.63
	SCMS13: Having a sustainable attitude means owning fewer items but ensuring they are of high quality.			0.44

**Source:** Author's own research.

### 4.3. Confirmatory Factor Analysis

We proceeded with the confirmatory factor analysis (CFA) to assess the structural validity of the model established in the EFA process. During this stage of the analysis, we employed the following model fit indices: Root Mean Square Error Approximation (RMSEA), Standardized Root Mean Square Residuals (SRMR), Comparative Fit Index (CFI), and Tucker-Lewis Index (TLI). The values of these indices were compared with the cut-off guidelines found in the literature, universally recognized as RMSEA under 0.06, SRMS under 0.08, CFI over 0.9, and TLI over 0.9. Our indices were found to have the following values: RMSEA = 0.058, SRMR = 0.038, CFI = 0.961, and TLI = 0.950. Building on the satisfactory results, we proceeded to analyse a second-order model with a four-factor structure. Two different statistical techniques were used to assess the goodness-of-fit indicators. We first used the “marker” method within the “lavaan” package. (R, 2024), leading to the following results: RMSEA = 0.059, SRMR = 0.046, CFI = 0.959, and TLI = 0.950. For the second approach, we employed the “var std” procedure from the same library to assess the model, which resulted in the following values: RMSEA = 0.058, SRMR = 0.031, CFI = 0.961, and TLI = 0.951. According to the CFA, the three-factor and four-factor models show strong performance, implying they measure the same underlying

concept. Additionally, both second-order models indicate a broader construct, that is the core concept of sustainability or the interconnection between all latent variables. Table 4 provides a comprehensive overview of the CFA results.

**Table 4.** *Confirmatory Factor Analysis Goodness of Fit indices*

	RMSEA (*<0.06)	SRMR (*<0.08)	CFI (*>0.9)	TLI (*>0.9)
Three-factor model	0.058	0.038	0.961	0.950
Second-order model 1	0.059	0.046	0.959	0.950
Second-order model 2	0.058	0.031	0.961	0.951

**Source:** Author's own research.

## 5. Discussion and Implications

The Sustainable Clothing Measurement Scale (SCMS) consists of thirteen items designed to comprehensively assess different aspects of sustainable clothing consumption. Developed in alignment with the sustainability principles highlighted in the literature (Purvis et al., 2019; Shen et al., 2013; World Commission on Environment and Development, 1987), it addresses dimensions like sustainability awareness, attitudes toward sustainable clothing, and awareness of eco-friendly clothing practices.

Both the EFA and CFA procedures provided strong support for the reliability and validity of the scale. The EFA analysis uncovered three unique factors in the scale created for this study: general sustainability, sustainable clothing, and sustainable attitude. The predictors showed strong internal consistency, as indicated by Cronbach's alpha values. The structural validity of the scale was further confirmed through the CFA procedure, with the three-factor and four-factor models presenting favourable fit indices. The statistical procedures revealed a potential underlying latent construct, specifically the fundamental concept of sustainability. This potential variable confirms Iacob and Popescu's (2015) idea of interconnectivity that emphasizes the ongoing communication among components. This highlights the scale's holistic perspective on sustainability and enables an emphasis on the interplay between economic, environmental, and social elements, transcending individual dimensions to drive sustainable practices.

The findings of this study provide essential guidance for advancing academic understanding and practical advocacy for sustainable clothing consumption within the Romanian context. Through the development of the SCMS scale, we contribute to academic research by offering a novel tool to explore individuals' understanding and attitudes toward sustainable clothing consumption. The existing scales designated for understanding sustainable clothing consumption, namely Sustainable Apparel Consumption Scales, (Zhang, 2014) Sustainable Clothing Consumption Scale, (Park and Lee, 2021) and Sustainable Fashion Awareness Scale, (Shen et al., 2013), are exclusively targeting the consumption dimension of sustainable clothing, or the behavioural aspect that triggers one's decision to choose sustainable clothes. The novelty of SCMS stands in its holistic approach, trying to uncover one's knowledge of sustainability, and sustainable clothing and also explore the attitudes towards this particular type of apparel.

The rising attention among scholars, policymakers, and businesses to explore and understand consumers' sustainable consumer behaviour and find strategies to foster these particular practices could be satisfied. (Mehrotra et al., 2024) The insights gained from the use of the SCMS could provide a foundation for designing programs and policies to enhance sustainable consumer behaviour in Romania. From this perspective, the fashion industry can position itself as a major beneficiary of the SCMS. Businesses should know how sustainability and sustainable clothing are perceived by consumers so that they can improve their marketing campaigns. Understanding consumer perceptions and preferences through the scale could assist in adapting sustainable fashion products to address their needs. Although governments have put forth regulations to foster sustainability, motivating businesses to integrate sustainable practices (Abbate et al., 2024), Pereira (2021) insists on more aggressive policies, since there is a lack of access to this subject of interest. Thus, the three constructs provided through SCMS, namely sustainability, sustainable clothing, and sustainable attitude wish to understand consumers' level of awareness within this area of interest. Moreover, key stakeholders within the fashion sector could use the scale's insights to adapt their strategies and product lines to better resonate with consumer preferences and values.

Ultimately, we consider the SCMS to bring significant aid in fostering the evolution of the sustainable fashion industry since it wishes to uncover consumers' knowledge of sustainability, sustainable clothing, and attitudes towards sustainable clothing for a more effective alignment with their needs.

## 6. Conclusion

This study successfully established and validated the Sustainable Clothing Measurement Scale (SCMS) to bridge the gap in assessing consumers' knowledge and attitudes toward sustainable clothing consumption, with a focus on Romanian consumers. We integrated key concepts from the current body of literature with the widely recognized principles of sustainability and designed a comprehensive instrument specifically tested for Romanian consumers.

Consisting of thirteen items, the SCSMS serves as a robust instrument that provides a thorough assessment of sustainable clothing consumption across different dimensions, with responses recorded on a seven-point Likert scale. The tool was adapted to be culturally suitable and easily accessible for the 1,250 Romanian respondents who provided their assessment. Through statistical procedures like EFA and CFA, all thirteen items were validated and contributed to defining the three predictors, namely general sustainability, sustainable clothing, and sustainable attitude. The validity and reliability of the instrument were assessed using the same statistical methods, with significant results that promote future research in the fields of tool development and sustainable clothing consumption.

A limitation of this study is the possibility of biases introduced by the online survey format and the reliance on self-reported data, which might restrict the broader applicability of the results. A further limitation arises from the skewed demographic, with a majority of female participants, potentially affecting the generalizability of the findings. Moreover, this



specific group within the sample could influence the results, favouring certain characteristics of sustainability comprehension. To mitigate this limitation, future studies could use alternative data collection methods that improve generalizability and ensure a more demographically balanced sample. Additionally, the scale's design and conceptual framework are primarily grounded in existing literature, without the inclusion of other specialized viewpoints incorporated into the final version. Consequently, the crafting process of the instrument may have overlooked certain important aspects of sustainability and sustainable clothing, leaving them insufficiently addressed. Also, the choice of statistical procedures applied might have restricted the scope of exploring the tool's statistical features. Future research should focus on pinpointing and resolving these issues to enhance the scale's effectiveness. Acknowledging these limitations provides a groundwork for future studies that will focus on advancing sustainable clothing consumption.

Ultimately, the Sustainable Clothing Measurement Scale is an innovative approach to understanding consumers' level of knowledge on sustainability and sustainable clothing, along with attitudes towards sustainable clothing in Romania. We also regard this study as an important milestone in advancing sustainability for the fashion sector and other industries. The significance of this research lies in the relevance of the sector studied and the innovative approach to addressing the gap found within specialized literature, particularly within the Romanian context.

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## **Estimating Romania's potential GDP: a production function and multivariate approach**

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**Abstract.** *This research assesses Romania's potential GDP and its variances employing the production function methodology and a multivariate approach. The Cobb-Douglas function measures potential production by integrating labor, capital, and total factor productivity (TFP), utilizing Kalman filtering for labor and the perpetual inventory approach for capital. TFP trends are derived using the Hodrick-Prescott filter. A multivariate filter enhances potential GDP estimates by correlating output gaps with inflation, unemployment, and capacity utilization. Bayesian methodologies guarantee reliable parameter estimate. The results indicate cyclical variations, with recessions and crises exerting enduring impacts on potential output. Structural changes and EU entry foster long-term resilience, although inflation and labor dynamics are crucial factors. This work enhances the precision of potential GDP calculation in a growing economy by integrating various estimation methodologies. It presents empirical information regarding the enduring impacts of economic shocks and furnishes insights for policymakers in formulating efficient fiscal and monetary responses to macroeconomic volatility.*

**Keywords:** potential GDP, production, multivariate, TFP.

**JEL Classification:** E32, E37, E52, C32, C53.

## 1. Introduction

This study enhances the literature by combining production function methods with a multivariate filtering strategy to estimate Romania's potential GDP, thereby filling a notable gap in current research. Previous studies on potential output estimation have predominantly utilized univariate statistical filters or simple production functions, frequently neglecting the dynamic interrelationships among economic variables such as inflation, unemployment, and capacity utilization. This research improves estimation accuracy by integrating the Phillips curve, Okun's law, and capacity utilization equations, optimized using Bayesian methods. Furthermore, although analogous approaches have been widely utilized in industrialized economies, their application in Romania is still constrained, rendering this study one of the first efforts to implement a full multivariate framework in a developing economy characterized by significant structural transformations and external vulnerabilities.

Precise calculation of potential GDP is crucial for comprehending an economy's sustained growth potential and formulating appropriate macroeconomic strategies. Potential output is a crucial benchmark for recognizing business cycle variations, evaluating inflationary dynamics, and adjusting monetary and fiscal strategies. This is especially pertinent in Romania, where economic instability has been shaped by many crises, including the 2008 financial collapse, the COVID-19 pandemic, and geopolitical conflicts.

The results demonstrate the enduring impact of economic shocks on potential output, emphasizing the significance of structural reforms and EU accession in influencing Romania's long-term economic path. This study enhances the precision of potential GDP measurement and output gap evaluation, offering policymakers a more dependable instrument for economic forecasting, inflation targeting, and fiscal planning. The findings provide significant insights for developing economies encountering analogous macroeconomic issues, highlighting the necessity of employing various estimation methods for a more thorough comprehension of economic variations.

## 2. Literature Review

Estimating potential GDP is a pivotal subject in macroeconomic study due to its significance in informing monetary policy, analyzing inflationary pressures, and determining long-term economic viability. The literature presents several ways for estimating potential output, which can be broadly classified into statistical filtering methods, production function approaches, and multivariate models. Every strategy possesses distinct advantages and drawbacks, especially within the framework of growing economies like Romania.

A prevalent method involves the utilization of statistical filters, such the Hodrick-Prescott (HP) filter (Hodrick & Prescott, 1997) and the Band-Pass filter (Baxter & King, 1999). These methods partition real GDP into trend and cyclical components, presuming a gradual progression of potential output. Nonetheless, they lack a clear connection to economic

fundamentals, frequently yielding skewed estimates that are susceptible to parameter selection (Hamilton, 2018). Research utilizing these filters in Romania (Lupu & Asandului, 2020) has shown inconclusive outcomes, especially during economic shocks, when statistical filters often exaggerate volatility.

A structural approach utilizes the production function methodology to breakdown potential output into its essential supply-side components: capital, labor, and total factor productivity (TFP). This approach is extensively utilized by organizations such as the European Commission (Denis et al., 2006) and the OECD (Girouard & André, 2003). The Cobb-Douglas production function, under the assumption of constant returns to scale, has been extensively utilized in empirical research (Borio et al., 2013), although its implementation in Romania is still constrained. Certain studies (Altar et al., 2010) have assessed Romania's potential GDP through production functions, predominantly utilizing deterministic trends for labor and capital, but neglecting a stochastic framework for the underlying dynamics.

Recent research has shifted towards multivariate filtering models, which improve potential GDP estimation by integrating macroeconomic linkages. These methodologies, frequently grounded in the Kalman filter (Laubach & Williams, 2003), amalgamate economic variables such as inflation, unemployment, and capacity utilization to enhance output gap estimations. The European Central Bank (Havik et al., 2014) has implemented a multivariate methodology for euro area nations, showcasing its efficacy in enhancing GDP trend estimations. In Romania, limited research has systematically integrated multivariate filtering with the production function approach, resulting in a gap in the literature.

This work fills the gap by combining a production function approach with a multivariate model that includes the Phillips curve, Okun's law, and capacity utilization equations to enhance potential GDP estimations. This study employs Bayesian estimating techniques to enhance model precision, in contrast to prior research that concentrated on statistical filters or production functions independently. Furthermore, although multivariate filtering has been extensively utilized in industrialized economies (Benes et al., 2010), its implementation in Romania is limited, despite the nation's susceptibility to significant economic volatility.

This study offers a more robust evaluation of Romania's potential output by integrating structural and multivariate methodologies. The results enhance the current discourse on output gap assessment in emerging economies, providing novel perspectives on the enduring impacts of crises and structural transformations on economic capacity.

### 3. Data and methodology

The assessment of potential GDP relies on macroeconomic data for Romania from the third quarter of 2003 to the fourth quarter of 2023. The primary data sources comprise Eurostat, which offers real GDP series (seasonally adjusted and adjusted for working days) and Gross Fixed Capital Formation (GFCF); the International Labour Organization (ILO), which furnishes labor force data; the National Bank of Romania (BNR), which supplies Core

Inflation data; and the National Institute of Statistics (INS), which presents data on the Consumer Price Index (CPI). The real GDP series is utilized to ascertain prospective GDP, whilst the capital stock is calculated via the perpetual inventory approach, modified with a quarterly depreciation rate of 1.23% (as per Altar et al., 2010).

The estimation of potential GDP is conducted using two complementary methodologies:

1. The Cobb-Douglas Production Function with constant returns to scale, expressed as:

$$Y_t = TFP_t \cdot K_t^\alpha \cdot L_t^{1-\alpha}$$

where:

$Y_t$  represents real GDP,

$K_t$  is the capital stock,

$L_t$  is the labor force,

$TFP_t$  denotes total factor productivity,

The output elasticities are  $\alpha=0.35$  for capital and  $1-\alpha=0.651$  for labor, following the European Commission's methodology.

The TFP estimation is derived as a Solow residual, while its trend is determined using the Hodrick-Prescott filter ( $\lambda=1600$ ).

2. The Multivariate Model, which extends the estimation of potential GDP by integrating economic relationships through the Phillips Curve, Okun's Law, and capacity utilization equations. This approach refines potential output estimation by explicitly incorporating macroeconomic dynamics rather than relying solely on statistical filtering.

The model specification includes the following key equations:

Output gap estimation:

$$gap_{Y,t} = 100 \cdot \log\left(\frac{Y_t}{Y_t^*}\right)$$

where  $Y_t$  is actual GDP and  $Y_t^*$  is potential GDP.

NAIRU and equilibrium unemployment rate:

$$u_t - u_t^* = \beta_1 gap_{Y,t} + \beta_2 (u_{t-1} - u_{t-1}^*) + \epsilon_t$$

where  $u_t$  is the actual unemployment rate,  $u_t^*$  is the non-accelerating inflation rate of unemployment (NAIRU), and  $\epsilon_t$  is the error term.

a) Inflation and output gap relationship (Phillips Curve):

$$\pi_t = \gamma_1 \pi_{t-1} + \gamma_2 gap_{Y,t} + \epsilon_t$$

where  $\pi_t$  represents core inflation.

b) NAIRU estimation using the Kalman filter to extract the equilibrium component of the unemployment rate.



c) Capacity utilization dynamics:

$$cap_t - cap_t^* = \delta_1 gap_{Y,t} + \delta_2 (cap_{t-1} - cap_{t-1}^*) + \epsilon_t$$

where  $cap_t$  is actual capacity utilization and  $cap_t^*$  is its equilibrium level.

The model parameters are estimated using Bayesian techniques, ensuring a robust identification of potential GDP by integrating prior information on macroeconomic relationships. This approach enhances accuracy compared to purely statistical filtering methods by explicitly modeling the interactions between GDP, inflation, unemployment, and capacity utilization.

## 4. Results and discussion

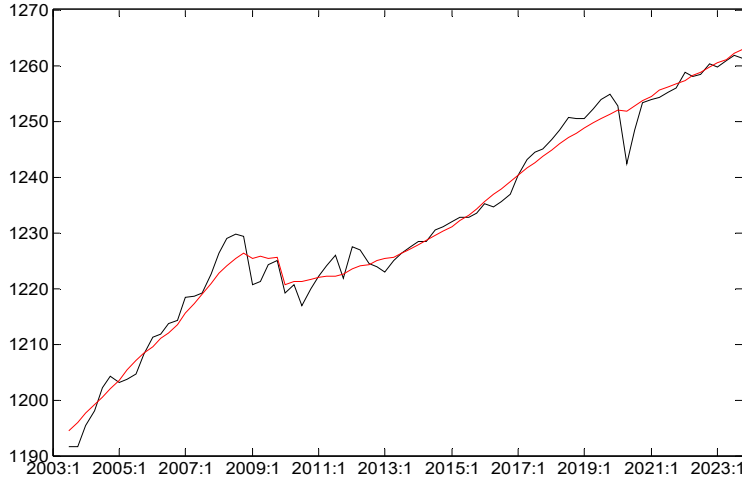
### 4.A. Labour Function

The outcomes derived from the production function methodology establish a robust basis for evaluating potential GDP. This approach predominantly emphasizes supply-side factors and fails to explicitly consider macroeconomic linkages, including inflationary dynamics and labor market rigidities. To mitigate these constraints and improve the reliability of potential GDP calculation, we expand our study through a multivariate approach that incorporates supplementary macroeconomic linkages.

Figure 1 illustrates the correlation between actual GDP and projected potential GDP derived from the production function. Although the overarching trend corresponds with existing work (e.g., Altar et al., 2010; Denis et al., 2006), our findings underscore the significance of structural determinants in influencing the trajectory of potential output. Throughout the reviewed period, the real quarterly GDP exhibited a consistent rising trajectory. Concurrently, its trajectory, assessed through the production function, exhibited analogous patterns, including throughout the financial crisis, a phase of quasi-stagnation in the growth rate of potential GDP (2009-2013). Subsequently, the trend reverses, but at a diminished slope relative to the pre-crisis period, highlighting the repercussions of the recession, referred to in the literature as the scarring effects of production (Larch et al. 2022).

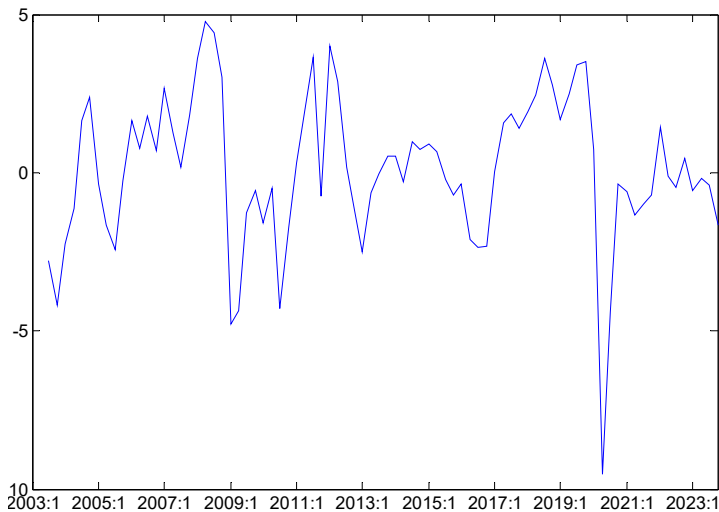
The scarring effects of the 2009 financial crisis are evident in our calculations, akin to those reported by Larch et al. (2022), underscoring the enduring influence of economic downturns on supply-side factors.

It is important to acknowledge the inflationary pressures associated with the financial crisis from 2008 to 2011, stemming from GDP growth exceeding potential levels, alongside its decline during the recessionary period. The substantial increase in potential GDP is attributed to the contributions of production factors, particularly the capital stock and factor productivity, following Romania's entrance to the European Union. Similar to the previously employed statistical filters (HP and Band-Pass), the potential GDP maintained its growth trajectory during the COVID-19 pandemic, with the decline in production during the quarantine reflecting a deviation rather than impacting the economy's potential level.

**Figure 1.** GDP and potential GDP in the period 2003 Q3 – 2023 Q4

**Source:** Own research.

Figure 2 illustrates the GDP gap derived from the production function. The inflationary pressures preceding the financial crisis, marked by a positive production gap, are significant. During the crisis, the GDP gap contracted by about 10 percentage points, shifting from +5% above potential to -5% below potential.

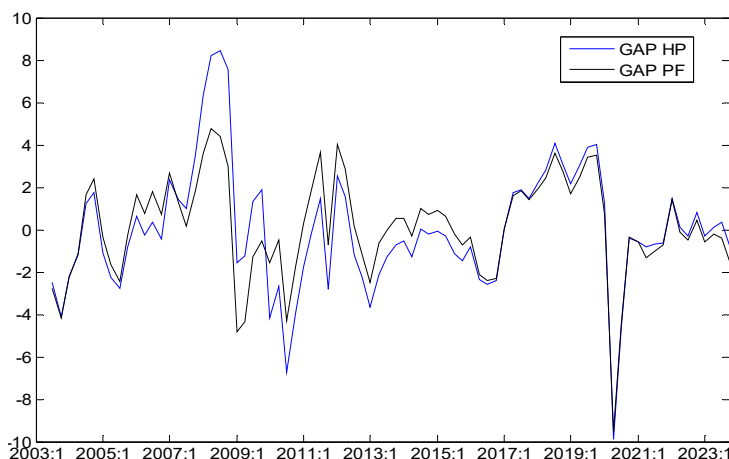
**Figure 2.** GDP deviation Results corresponding to the production function

**Source:** Own research.

The GDP deviation projected by the production function indicates a "overheating" of the economy prior to the financial crisis, a phenomenon previously emphasized by statistical filters. The pandemic era is marked by a significant decrease in deviation to 10% below the potential level.

The economy's recovery is strong, resulting in the GDP gap being eliminated swiftly by 2021Q4. However, it is expected to diminish and subsequently enter negative territory in 2022 due to the onset of the war in Ukraine and the implementation of tighter monetary policy to address inflationary pressures.

**Figure 3.** Comparison of the gap obtained by the HP statistical filter and the FP filter



**Source:** Own research.

It can be seen from Figure 3 that the deviation estimated by the HP filter is much more volatile than that of the production function, although during the pandemic the decrease in the output gap is similar in magnitude in both cases.

#### 4.B. Multivariate method

To enhance the production function estimations, we utilize a multivariate filtering method that considers demand-side effects on potential output. This method, unlike univariate statistical filters (e.g., HP filter) that lack economic grounding, incorporates relationships such as the Phillips curve and Okun's law, hence improving the interpretability of the predicted output gap.

The Bayesian methodology, namely the maximum regularized probability, is employed to estimate the model (Ljung 1999). The presence of non-informative data across several parameters enables the establishment of a priori distributions that prevent parameters from being entrenched in irrelevant regions. Additional details regarding this strategy are available in Annex 2. Considering the model, its parameters, and the data creation procedure, analytical estimations of the confidence intervals derived from the sample information are given. The analysis period for Romania extends from the third quarter of 2003 to the fourth quarter of 2023, with a further forecast period extending to 2027. Integrate the following equation into the model to guarantee that the rise in potential output remains closely aligned with its steady-state value.

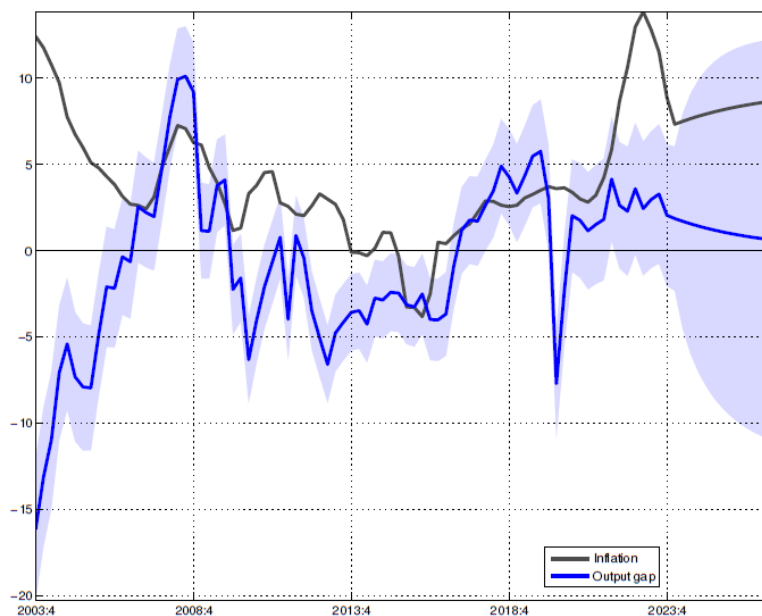
#### 4.B.1. GDP gap and core inflation

Given that the interaction between these two variables encapsulates the essential elements of the model and the resultant estimates, it is prudent to initially report the findings of the multivariate filter concerning the GDP gap and inflation. Alongside the central estimate for the GDP gap, Figure 4 presents a confidence interval of  $\pm 2$  standard deviations. The inflation rate is defined as the percentage change in the core consumer price index.

A monetary policy framework focused on direct inflation targeting must consider the correlation between inflation and the GDP gap. Prior to 2005, there was no significant association between GDP and inflation, coinciding with the NBR's adoption of a direct inflation targeting method. Nonetheless, the graph displayed clearly demonstrated a link between the two variables. Despite the GDP gap remaining negative in 2005 and 2006, inflation persisted in its decrease, reaching nearly zero in the first quarter of 2007 at -0.57% of GDP.

Demand has been positive and the economy has grown faster than expected in the years before the financial crisis. Consequent to the financial crisis, GDP commenced its decrease, and the disparity began to diminish. The model indicates that the GDP gap transitioned into positive territory toward the end of 2015 and the beginning of 2016, signifying a gradual and sustained return to equilibrium.

**Figure 4.** *GDP Gap and Inflation*



**Source:** Own research.

The narrowing of the GDP gap between 2014 and 2015 suggests that inflation is steadily nearing equilibrium, and inflationary pressures will ultimately dissipate when actual output reaches its potential. The output gap experiences a little increase from 2016 onward,

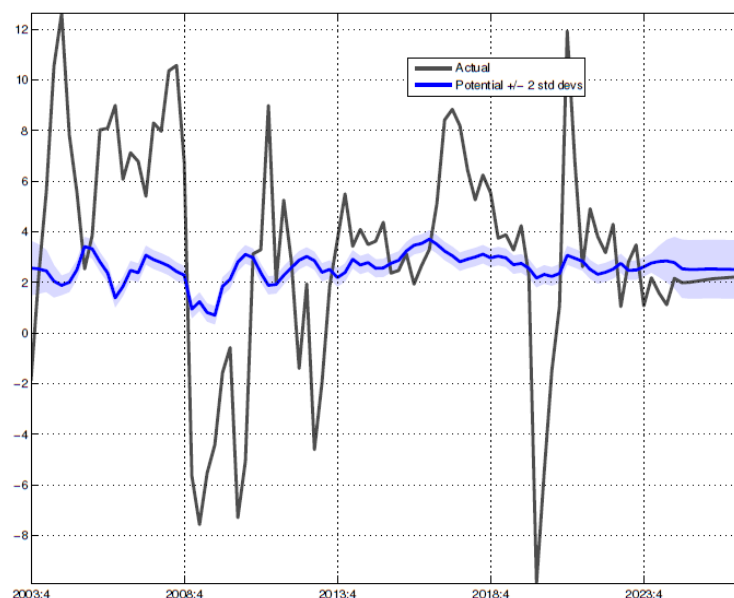
thereafter narrowing progressively; however, from 2017, GDP exhibits substantial growth, maintaining the output gap in a favorable condition. The COVID-19 pandemic and the deceleration of economic activity are resulting in a significant and quick decline in GDP. Consequently, the GDP gap expands to -7.5% of GDP, marking the most significant negative level within the investigated timeframe, excluding the period prior to the implementation of the NBR's direct inflation targeting method. By the end of 2023, a recovery is evident, and predictions suggest that real GDP is nearing its potential, with an output gap of approximately 1%.

The estimated GDP gap derived from the multivariate filter (Figure 4) indicates a pronounced cyclical component, aligning with theoretical expectations regarding inflation-output dynamics. The findings validate that during phases of economic overheating (2007–2008), inflationary pressures escalated, a trend similarly documented by Havik et al. (2014) for euro area nations. Our estimates indicate a significant reduction in the output gap following the 2008 financial crisis, consistent with other research (Benes et al., 2010).

#### 4.B.2. Potential Gross Domestic Product

Figure 5 juxtaposes the growth rate of actual GDP against potential GDP. The reduction in potential GDP growth after the 2008 crisis is more significant than the initial drop in actual GDP, indicating a lasting impact on supply-side circumstances. This observation aligns with Borio et al. (2013), who underscore the significance of financial cycles in shaping long-term output trends. Our calculations indicate that the COVID-19 pandemic exerted a less effect on potential GDP growth than the financial crisis, a trend also evident in other rising economies.

**Figure 5.** Growth rate of actual and potential GDP



**Source:** Own research.

The graphic above illustrates the impact of the 2008 economic recession on actual and projected GDP growth rates. The recession adversely affected potential GDP growth more significantly than actual growth, which plummeted precipitously after the onset of the COVID-19 pandemic. The economy has been profoundly impacted by the recession, resulting in a diminished prospective growth rate. Given the advancements in each sector, the growth rate reverts marginally to its prior level. The forecast suggests that, in the forthcoming term, the economy will stabilize and align with the potential growth rate.

#### **4.B.3. Unemployment Rate and NAIRU Trend**

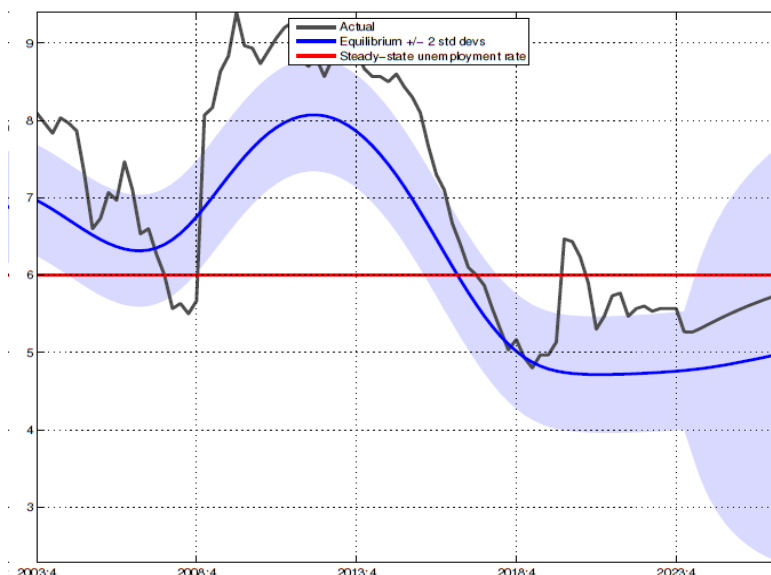
With rare exceptions, when the unemployment rate was in a positive although minimal range, the divergence was primarily negative. The rise in the unemployment rate during the 2008 financial crisis and the hysteresis effect are primarily responsible for this predicament. From 2007 to 2008, the negative correlation between inflation and unemployment was evident: as inflationary pressures rose, both effective and equilibrium unemployment rates decreased.

The unemployment rate mostly exhibits a negative deviation, primarily reflecting the effects of the financial crisis. Nonetheless, given the economy has rebounded and advanced more rapidly than anticipated (particularly in the latter half of 2015 and the initial quarter of 2016, as illustrated in Figure 1.9), the model forecasts that the unemployment rate will ascend to equilibrium in the forthcoming period. This can be elucidated by the implementation of fiscal policies aimed at augmenting both the demand and supply of labor, the incorporation of the jobless into the workforce, and the provision of subsidies to employers.

The NAIRU and the unemployment rate align with the long-term equilibrium value within the same timeframe (Figure 6). In 2018, a gain in GDP and growth rate corresponds with a significant decline in the unemployment rate; but, as shown in prior instances, the pandemic in 2020 leads to a temporary surge in unemployment, confined to the duration of the quarantine.

The health issue has adversely affected the progression of the labor market. This is logical considering the quarantine limits that have been implemented, resulting in the technical unemployment of numerous employees. Since 2021, the unemployment rate has consistently stayed below the equilibrium threshold of 6%. The projections suggest that the unemployment rate and the NAIRU will exhibit a comparable trajectory aligned with the equilibrium level in the forthcoming future.

The unemployment rate decreased consistently throughout the examined period. The unemployment rate decreased from 8% to 5.5% by the conclusion of the fourth quarter of 2023. The drop was mostly attributable to the enhancement of structural reforms and fiscal measures enacted to bolster the market, particularly in pursuit of this goal after the 2009 financial crisis.

**Figure 6.** Unemployment rate, NAIRU, equilibrium level of the unemployment rate

**Source:** Own processing.

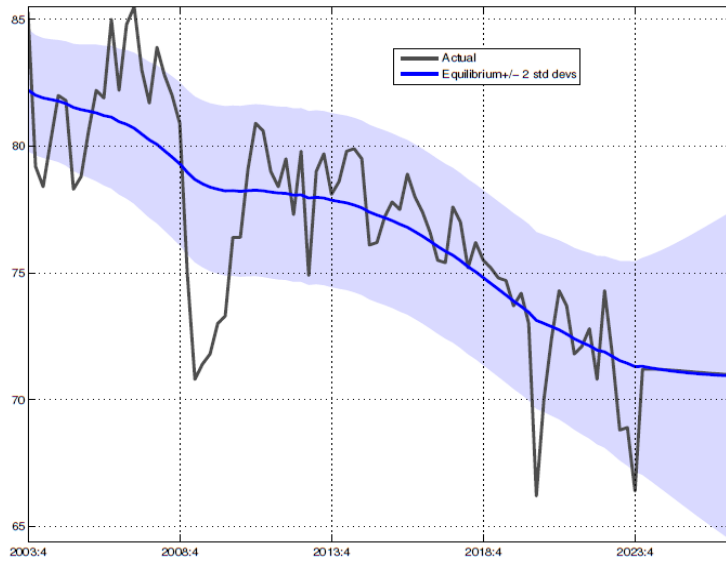
A primary imbalance is the inactivity of the 55-64 age demographic. The financial crisis has significantly elevated the jobless rate. In contrast to the pandemic crisis, which was characterized by a temporary shock, the shock associated with the global financial crisis was enduring, with significant repercussions for economic activity.

#### 4.B.4. Usability

The subsequent section will provide the evolution of usability and its trend component, which illustrates the relationship between the output generated with available resources and the potential output achievable if this capacity were fully utilized.

There exists a positive correlation between GDP and capacity utilization (Figure 7); a decline in the GDP gap is promptly succeeded by a decrease in the capacity utilisation gap. The model demonstrates the impact of the 2008 financial crisis on capacity utilization, indicating a decline in capacity utilization from 2009 to 2013. The extent of the drop throughout the crisis was approximately 10 percentage points, and in contrast to the pandemic crisis or the energy crisis stemming from the Federation's invasion of Ukraine, the disparity in the financial crisis was markedly greater.

The correlation between GDP variations and capacity utilization further substantiates the cyclical characteristics of economic activity. Consistent with Hamilton's (2018) findings, our data demonstrate that the financial crisis resulted in a sustained underutilization of economic potential, while the COVID-19 shock had a more ephemeral impact. This distinction is essential for policy formation, indicating varied recovery strategies based on the type of economic shock.

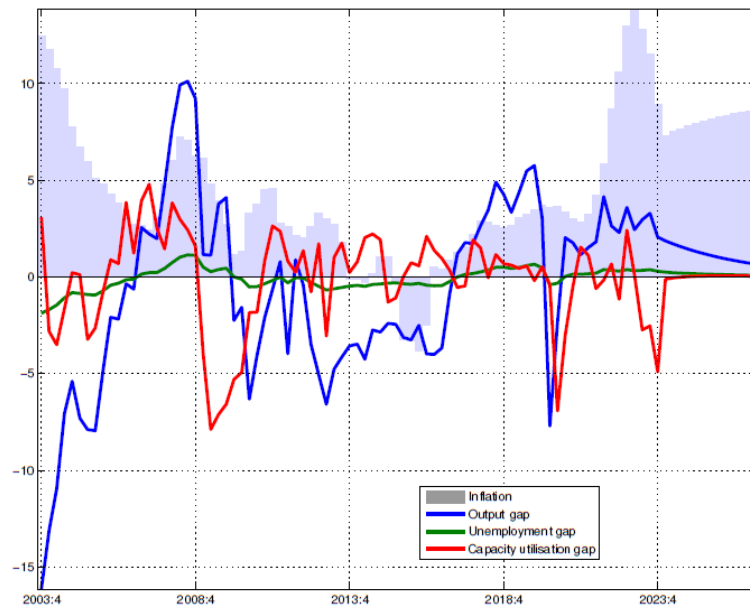
**Figure 7.** Usability and its trend (its equilibrium value)

Source: Own processing.

#### 4.B.5. Estimates of deviations

The subsequent section will give the three gaps corresponding to the original equations.

i) Deviation of GDP, ii) Deviation of the unemployment rate, iii) Deviation of usability.

**Figure 8.** Inflation. GDP deviation. Deviation of the unemployment rate. Usability deviation

Source: Own processing.



Low productivity and inadequate capacity utilization are the primary causes of the three adverse deviations at the onset of the model sample, resulting in a sustained negative output deficit, as the actual growth rate fell somewhat behind the potential growth rate. The progress observed in 2005-2006 may be attributed to the adoption of the National Bank of Romania's new monetary policy framework, specifically the direct targeting of inflation.

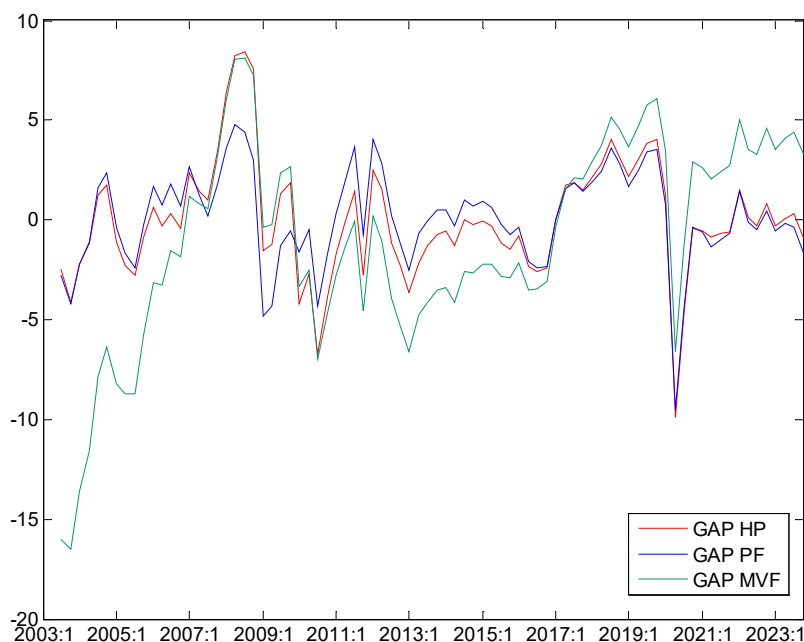
In 2007 and 2008, there was sustained economic growth, primarily attributable to admission to the European Union, with growth rates surpassing potential, a decline in the unemployment rate, and an increase in total factor productivity.

The economic slowdown following the financial crisis at the end of 2008 led to a negative output deviation and a diminished potential growth rate. During 2013-2014, GDP approached its potential level, thereby closing the GDP gap. The GDP gap and the capacity gap have developed concurrently across the whole time frame. The realized values are likely to align with the equilibrium state, consistent with projections for the forthcoming three years.

Figure 8 illustrates that the GDP gap and the capacity gap will diminish subsequent to the closure of the unemployment gap.

After estimating the GDP gap using the multivariate filter, we compared it with the two previously calculated GDP deviations (Figure 9), derived from other models, specifically the production function and the HP filter.

**Figure 9.** Results corresponding to the GDP deviation obtained by the 3 methods



**Source:** Own processing.

Consequently, the distinction between the outcomes of the two multivariate methodologies (Kalman and the Production Function) is evident, as the former considers interconnections among economic data, whereas the HP filter solely accounts for the dataset itself. The Kalman filter exhibits a more pronounced departure at the onset of the data series compared to the other two, resulting in a significantly more volatile series.

The linearity of the HP filter yields unique outcomes. During the pandemic, the reduction in the output gap is nearly uniform across all three specifications (about -10%); but, in the crises preceding the pandemic, the multivariate filter appears to identify a more significant negative deviation compared to the other models. The Kalman filter indicates a return to positive deviation following the pandemic crisis, coinciding with the resurgence in demand and the easing of economic activity conditions.

An examination of GDP gap estimates across various techniques (Figure 9) reveals significant disparities in their sensitivity to economic swings. The HP filter yields a more refined estimate, whereas the production function and multivariate approaches identify more pronounced aberrations, especially during crises. In accordance with prior research (Havik et al., 2014; Lupu & Asandului, 2020), our findings indicate that the incorporation of macroeconomic linkages improves the precision of potential GDP estimations, rendering them more appropriate for policy analysis.

## 5. Conclusions

This study sought to estimate Romania's potential GDP by a dual approach that integrates the Cobb-Douglas production function with a multivariate filtering technique. The analysis utilized quarterly macroeconomic data from Q3 2003 to Q4 2023, obtained from Eurostat, the International Labour Organization, the National Bank of Romania, and the National Institute of Statistics. The production function technique dissected potential output into its fundamental supply-side elements—capital, labor, and total factor productivity—whereas the multivariate method included interactions like the Phillips curve, Okun's law, and capacity utilization dynamics. Bayesian estimate methods were utilized to guarantee reliable parameter identification, hence improving the precision of potential GDP assessment.

The results underscore significant cyclical variations in Romania's economy from a statistical standpoint. The production function estimates indicate a consistent rise in potential GDP, accompanied with discernible scarring effects post-2008 financial crisis, akin to conclusions drawn in the literature. The multivariate filter method identified more significant variances, especially during economic downturns, validating the robust correlation among GDP variations, inflationary trends, and unemployment changes. The analysis of estimation techniques indicated that statistical filters, like the HP filter, generally underestimate structural changes, but multivariate methods yield more responsive and economically significant estimates. The output gap study revealed that

Romania's economy faced overheating prior to the financial crisis and had a swift contraction during the COVID-19 epidemic, followed by a rebound propelled by robust fiscal and monetary support measures.

These findings yield various policy recommendations. Policymakers should incorporate several estimation methods when evaluating potential GDP to achieve a more thorough understanding of economic variations. Secondly, structural reforms designed to enhance labor market flexibility and productivity development must be emphasized to alleviate the long-term consequences of economic recessions. Third, considering the inflation-output correlation identified in the analysis, monetary authorities ought to meticulously observe output gaps when formulating inflation-targeting policies. Finally, specific fiscal policies that promote capital accumulation and labor force engagement might aid in maintaining potential GDP growth, especially amid external shocks and economic instability. These ideas furnish essential insights for Romanian policymakers and present a framework relevant to other rising economies encountering analogous macroeconomic issues.

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