The Impact of CO2 Emissions, Domestic Investment and Trade Openness on Economic Growth: New Evidence from North African Countries

El Weriemmi, Malek and Bakari, Sayef

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Malek El Weriemmi

Research Unit 'Enterprise Economy Environment', Higher Institute of management, University of Gabes, Tunisia.

E-mail : Malek.el-weriemmi@laposte.net

Sayef Bakari

LIEI, Faculty of Economic Sciences and Management of Tunis, University of Tunis El Manar, Tunisia.

Faculty of Legal, Economic and Management Sciences of Jendouba, University of Jendouba, Tunisia.

Email: bakari.sayef@yahoo.fr

Abstract:

This study aims to investigate the impact of CO2 emissions, domestic investment, and trade openness on economic growth in North African countries over the period 1998 to 2022. Utilizing a panel static gravity model, the results reveal that domestic investment exerts a negative influence on economic growth, while CO2 emissions and exports demonstrate a positive contribution. Furthermore, the analysis suggests that imports have an adverse, though statistically insignificant, effect on economic growth. The findings underscore the importance of fostering policies that promote exports and mitigate CO2 emissions, while carefully considering the potential negative implications of imports on the economic growth of North African countries.

Keywords: CO2 Emissions, Domestic Investment, Trade Openness, Economic Growth, North African Countries, Panel Data, Gravity Model.

JEL Classification: F43, O13, Q56, C33, O55

1. Introduction

The examination of how CO2 emissions, domestic investment, and trade openness impact economic growth represents a pivotal area of research in today's global context, especially given the increasing focus on sustainable development. This topic is of profound significance as it addresses the pressing need to balance economic expansion with environmental stewardship. As the world faces the dual challenges of fostering economic growth while ensuring environmental sustainability, this research becomes ever more pertinent. The United Nations' Sustainable Development Goals (SDGs) highlight this imperative, particularly through Goal 8 (Decent Work and Economic Growth) and Goal 13 (Climate Action). These goals emphasize the necessity of promoting economic development while also mitigating the adverse effects of industrialization and globalization on the environment. CO2 emissions, a major driver of climate change, play a critical role in this discourse. Their reduction is essential for preserving ecological integrity and ensuring that economic growth can be sustained over the long term. A comprehensive understanding of the interplay between CO2 emissions, domestic investment, and trade openness is crucial, as these elements are deeply interconnected within the broader framework of sustainable development. Domestic investment often fuels economic growth by enhancing infrastructure, promoting technological advancement, and creating jobs. However, if not managed properly, it can also contribute to environmental degradation, including increased CO2 emissions. Similarly, trade openness can stimulate economic growth by expanding markets and fostering competition, but it can also lead to higher emissions if it results in increased industrial activity or resource exploitation. The investigation of these relationships is not only important for developing effective economic policies but also for crafting strategies that align with global sustainability objectives. By analyzing how these factors interact, we can gain insights into how to foster economic growth while simultaneously addressing environmental challenges. This research thus contributes to the broader sustainability agenda by providing evidence-based strategies for achieving economic development in a way that also respects and preserves environmental limits (Stern, 2007; OECD, 2019).

In the context of North African countries—Egypt, Libya, Tunisia, Algeria, and Morocco—this research topic is particularly significant. These countries are strategically positioned both geographically and economically, serving as a bridge between Africa, the Middle East, and Europe. However, they also face unique challenges that complicate their economic and environmental landscapes. North Africa is a region with considerable economic potential, driven by its rich natural resources, young population, and strategic trade routes. However, it is

also characterized by significant environmental vulnerabilities, including water scarcity, desertification, and the impacts of climate change. Moreover, the region has experienced various levels of political instability and economic volatility, which have further complicated efforts to achieve sustainable development (World Bank, 2020). Given these complexities, the impact of CO2 emissions on economic growth in these countries cannot be overstated. High levels of emissions not only contribute to global climate change but also have local environmental and health impacts that can undermine economic productivity and social well-being. In this regard, this research is crucial for providing insights into how North African countries can balance economic growth with environmental sustainability.

Furthermore, domestic investment plays a crucial role in the economic development of these countries. It is through domestic investment that economies can build infrastructure, create jobs, and foster innovation, all of which are essential for sustained economic growth. However, the effectiveness of domestic investment in promoting growth is contingent on various factors, including the environmental context within which it occurs. In regions where environmental degradation is rampant, the returns on investment may be diminished due to the adverse effects of pollution on health, productivity, and resource availability (Grossman and Krueger, 1995). Therefore, this research will explore how domestic investment interacts with environmental factors, particularly CO2 emissions, to influence economic outcomes in North Africa. This aspect of the study is particularly relevant given the region's ongoing efforts to attract foreign direct investment (FDI) and the need to ensure that such investments contribute to sustainable development (UNCTAD, 2021).

Trade openness is another critical variable in this research. North African countries have varying degrees of integration into the global economy, with some nations more open to trade than others. Trade openness can significantly influence economic growth by providing access to larger markets, facilitating technology transfer, and promoting competition and efficiency. However, it can also lead to increased environmental pressures, particularly in countries that rely heavily on the export of natural resources or industrial goods with high carbon footprints (Copeland and Taylor, 2004). This research will examine the dual role of trade openness in both promoting economic growth and contributing to CO2 emissions in North Africa. By doing so, it will provide a nuanced understanding of how these countries can leverage trade policies to achieve sustainable growth while minimizing environmental harm.

The scientific contribution of this research lies in its comprehensive and region-specific analysis

of the interactions between CO2 emissions, domestic investment, and trade openness in North African countries. While there is a substantial body of literature on the relationship between these variables in other regions, research focusing on North Africa is relatively limited. This study will fill this gap by providing new empirical evidence from a region that is both economically significant and environmentally vulnerable. The research will utilize advanced econometric methods to analyze data from Egypt, Libya, Tunisia, Algeria, and Morocco, offering insights that are directly applicable to policymakers in these countries. Moreover, by considering the specific socio-economic and environmental contexts of each country, this study will contribute to the broader understanding of sustainable development in developing regions. The findings of this research are expected to inform the design of policies that promote economic growth while addressing the environmental challenges faced by North African countries. This will be particularly valuable for achieving the SDGs in the region and ensuring that economic development is both inclusive and sustainable (UNEP, 2019; World Bank, 2020).

This research is poised to make a significant contribution to the understanding of how CO2 emissions, domestic investment, and trade openness interact to influence economic growth in North African countries. By focusing on a region that is both strategically important and environmentally challenged, this study will provide valuable insights for policymakers, academics, and practitioners interested in sustainable development. The research will not only enhance the academic literature on the subject but also offer practical recommendations for achieving balanced and sustainable economic growth in North Africa.

To structure this work comprehensively, we will organize it as follows: In Section 2, we will present a thorough literature review focusing on three primary relationships: first, the connection between CO2 emissions and economic growth; second, the relationship between domestic investment and economic growth; and third, the link between trade openness and economic growth. This review will critically analyze existing studies, theories, and empirical evidence to provide a comprehensive understanding of how these factors interact and influence economic outcomes. Section 3 will detail our empirical methodology, outlining the fundamental model used in our analysis, the variables considered, and the period of estimation based on the availability of data. This section will also describe our empirical strategy, explaining how we will apply our model to assess the relationships between CO2 emissions, domestic investment, and trade openness on economic growth. The goal is to provide a clear and detailed account of the methodological framework that supports our analysis. In Section 4, we will present the results of our empirical analysis. This section will offer a detailed examination of the findings,

interpreting the data and discussing how the results relate to the theoretical expectations and previous literature. The emphasis will be on presenting the evidence in a clear and organized manner to highlight the key insights derived from our research. Finally, Section 5 will conclude the study by summarizing the main findings and offering recommendations based on our results. This section will synthesize the implications of our findings for policy and practice, providing actionable recommendations to address the challenges identified in the study. The conclusions will reflect on the broader impact of our research on understanding the dynamics between CO2 emissions, domestic investment, trade openness, and economic growth.

2. Literature Survey

In this section, we will undertake a comprehensive and detailed literature review that will delve deeply into three core relationships that are central to our study. The first relationship we will explore is the connection between CO2 emissions and economic growth. This segment will thoroughly examine existing research on how variations in CO2 emissions impact economic performance, considering both theoretical perspectives and empirical findings. We will evaluate studies that discuss the direct and indirect effects of greenhouse gas emissions on various aspects of economic growth, including productivity, industrial output, and overall economic stability.

The second focus of our literature review will be on the relationship between domestic investment and economic growth. Here, we will review the body of work that investigates how domestic investment contributes to economic development. This will include an analysis of how investments in infrastructure, technology, and human capital drive growth, as well as the potential challenges and limitations associated with these investments. We will assess different theoretical frameworks and empirical studies that shed light on the mechanisms through which domestic investment influences economic outcomes.

The third and final area of focus will be the link between trade openness and economic growth. This part of the review will scrutinize how increased trade openness affects economic performance. We will explore research that examines the benefits and drawbacks of trade liberalization, including how it can lead to economic expansion by facilitating access to international markets, promoting competition, and encouraging innovation. Additionally, we will consider the potential negative impacts of trade openness, such as increased environmental pressures and economic dependency.

Through this extensive literature review, we aim to provide a nuanced and thorough understanding of how CO2 emissions, domestic investment, and trade openness interact to shape economic growth. By critically analyzing the existing body of knowledge, we will identify key insights, gaps, and areas for further research, thereby setting the stage for a more informed and detailed empirical analysis in subsequent sections of our study.

2.1.CO2 emissions and economic growth

The relationship between CO2 emissions and economic growth has been a focal point of numerous studies, reflecting the growing concern over environmental sustainability and its implications for economic development. Researchers have explored this relationship from various angles, seeking to understand whether economic growth inevitably leads to increased CO2 emissions, or whether there is potential for decoupling economic growth from environmental degradation. Acheampong et al. (2021) focus on the interplay between renewable energy, CO2 emissions, and economic growth in sub-Saharan Africa, revealing that economic growth drives carbon emissions. The study underscores the lack of causality between carbon emissions and renewable energy, indicating that while economic development is essential, it comes at the cost of increased CO2 emissions. This finding is crucial for policymakers in sub-Saharan Africa, where institutional quality and the adoption of renewable energy are pivotal in addressing climate change without hindering economic progress. Hubacek et al. (2021) further investigate the decoupling of CO2 emissions from economic growth, particularly through a consumption-based perspective. They find that while some developed countries have achieved decoupling, this success is often temporary and reliant on reducing emission intensity across supply chains. This study highlights the importance of international collaboration in achieving long-term decoupling, suggesting that efforts must extend beyond national borders to include global supply chains.

In the context of Pakistan, Abbasi et al. (2021) examine the effects of CO2 emissions, along with energy consumption and urbanization, on economic growth. Their results reveal that while carbon emissions positively impact economic growth in the short run, the long-term sustainability of this growth is questionable. This underscores the importance of integrating renewable energy sources and improving energy efficiency to ensure that economic growth does not lead to environmental degradation. The study by Inal et al. (2022) on African oil-producing countries reveals that CO2 emissions positively affect economic growth, particularly in countries like Algeria and Egypt. However, the neutrality of renewable energy's impact on

growth suggests underutilization of renewable resources. This finding calls for a reevaluation of energy policies in these countries to balance economic growth with environmental sustainability. Gao et al. (2021) explore the decoupling of CO2 emissions from economic growth in China, revealing a weak decoupling in most provinces. The study indicates that economic activities primarily drive emissions, with capital investment and total factor productivity being key contributors. The convergence of decoupling trends across provinces suggests that China is making progress toward a low-carbon economy, but challenges remain in fully decoupling growth from emissions. Hu et al. (2020) analyze the decoupling of CO2 emissions from economic growth along the Belt and Road Initiative (BRI). Their findings show that higher-income countries tend to have better decoupling statuses, while lower-income countries continue to struggle with rising emissions due to economic growth. This study emphasizes the importance of reducing energy intensity and addressing population growth as key strategies in mitigating CO2 emissions in developing regions.

Wang et al. (2020) focus on China's iron and steel industry, where they observe weak decoupling between carbon emissions and economic growth. The study identifies emission reduction and value creation as significant factors influencing decoupling, with energy efficiency improvements being essential for achieving stronger decoupling. The findings suggest that continuous efforts are needed to enhance energy efficiency and reduce emissions in energy-intensive industries. Burgess et al. (2020) criticize the baseline scenarios used by the Intergovernmental Panel on Climate Change (IPCC), arguing that they have over-projected CO2 emissions and economic growth. Their analysis highlights the divergence between observed trends and scenario projections, questioning the feasibility of achieving the high economic growth rates necessary to meet future emission reduction targets. This study calls for a reassessment of the assumptions underlying climate scenarios to better align with observed realities and future uncertainties. Chishti et al. (2021) emphasize the nonlinear effects of economic growth on CO2 emissions, highlighting the exacerbation of environmental degradation in economies heavily impacted by terrorism and foreign direct investments. This study underscores those positive economic shocks, often associated with increased foreign direct investment, tend to increase CO2 emissions, supporting the pollution haven hypothesis. The findings suggest that as economies grow, particularly under conditions of instability, there is a corresponding increase in environmental harm, calling for policies that promote cleaner technologies and stricter environmental regulations. Similarly, Namahoro et al. (2021) explore the impact of economic growth on CO2 emissions in African countries, with a focus on

variations across regions and income levels. The study finds a complex relationship where economic growth can both exacerbate and mitigate CO2 emissions depending on the region and the level of development. In Africa, economic growth generally contributes to higher CO2 emissions, especially in regions with high energy intensity. However, the promotion of renewable energy is shown to mitigate these effects, highlighting the importance of clean energy in managing the environmental impact of economic growth.

Onofrei et al. (2022) examine the long-run relationship between economic growth and CO2 emissions in EU countries, using a cointegration analysis. The study finds that economic growth in the EU is positively correlated with CO2 emissions, with a 1% increase in GDP leading to a 0.072% increase in emissions. This relationship underscores the challenges faced by developed economies in balancing economic growth with environmental sustainability. The study suggests that higher income levels and economic growth increase the demand for environmental protection, necessitating the design of policies that can reduce emissions during periods of economic expansion. In South Asia, Anser et al. (2021) investigate the impact of globalization and economic growth on CO2 emissions, revealing a bidirectional relationship. The study finds that while economic growth is essential for development, it often comes at the cost of environmental quality. The analysis shows that non-renewable energy consumption significantly contributes to higher CO2 emissions, and economic growth further exacerbates this effect. The findings align with the Environmental Kuznets Curve (EKC) hypothesis, where economic growth initially leads to environmental degradation, but beyond a certain income level, the relationship reverses as more resources are allocated to environmental protection. Li and Wei (2021) explore the relationship between CO2 emissions and economic growth in China, revealing regional differences and non-linear dynamics. The study finds that in both northern and southern regions of China, economic growth has a significant impact on CO2 emissions, but the degree and nature of this impact vary. The results indicate that higher levels of carbon emissions can diminish the positive effects of economic growth, particularly in regions where industrial activity is concentrated. This study highlights the importance of regional policies tailored to address the specific environmental challenges posed by economic growth.

Olubusoye and Musa (2020) provide insights into the relationship between CO2 emissions and economic growth in Africa, using the Environmental Kuznets Curve (EKC) framework. The study finds that in 79% of the African countries analyzed, economic growth leads to higher CO2 emissions, with only a small percentage of countries experiencing a reduction in emissions as

their economies grow. This suggests that economic development in most African countries is closely linked to increased environmental degradation, underscoring the need for policies that promote sustainable growth through renewable energy and carbon reduction strategies. In the context of China, Zhang and Zhang (2021) examine the interplay between tourism, economic growth, energy consumption, and CO2 emissions. Their findings indicate that economic growth and energy consumption are strongly correlated with CO2 emissions, with tourism also contributing to environmental degradation. The study emphasizes the importance of sustainable tourism practices and energy-efficient policies in mitigating the environmental impact of economic growth in rapidly developing economies like China. Anwar et al (2020) analyze the determinants of CO2 emissions in Far East Asian countries, highlighting the significant role of urbanization and economic growth. The study finds that rapid urbanization and economic expansion have led to a substantial increase in CO2 emissions in these countries. The authors suggest that sustainable urbanization, improved industrial structures, and increased use of renewable energy are crucial for reducing the environmental impact of economic growth in this region.

Bakari (2022a) explored the impact of several factors, including CO2 emissions, on economic growth across 52 African countries. The study revealed that CO2 emissions, along with innovation and internet use, did not significantly influence economic growth in the region. This suggests that, despite the global emphasis on environmental sustainability, CO2 emissions in these African countries have not yet manifested a notable impact on their economic trajectories, possibly due to the relatively lower levels of industrialization and the prioritization of other growth drivers like domestic investment and natural resources. In a more focused study on Sub-Saharan Africa, Bakari (2024a) assessed the impact of domestic investments and CO2 emissions on economic growth in 48 countries. Contrary to his earlier findings, this study found a positive and significant relationship between CO2 emissions and economic growth. This highlights the paradox often observed in developing regions where economic expansion, driven by increased industrial activity and energy consumption, concurrently leads to higher CO2 emissions. The study underscores the importance of adopting policies that balance economic growth with sustainable environmental practices. Bakari et al (2021a) extended the analysis to Tunisia, investigating the long-term effects of pollution, including CO2 emissions, on economic growth from 1971 to 2015. Their findings indicated a negative but insignificant impact of pollution on economic growth, suggesting that while pollution levels were rising, they had not yet reached a threshold where they could substantially hinder economic progress. However, the

study warns of potential future repercussions, advocating for proactive policies to mitigate the worsening effects of pollution over time. This theme of nuanced impacts is echoed in Bakari et al (2017), who also studied Tunisia's economic growth in relation to pollution. Their findings align with their later study, showing that pollution did not significantly reduce economic growth during the study period. However, they cautioned that continued environmental degradation could eventually harm economic performance, urging for early interventions to prevent future economic losses.

In a broader global context, Osobajo et al. (2020) examined the relationship between energy consumption, economic growth, and CO2 emissions across 70 countries. Their study found that both energy consumption and economic growth positively influenced CO2 emissions, reflecting the conventional growth model where increased energy demand, often met by fossil fuels, leads to higher carbon emissions. This study supports the need for a transition to a low-carbon economy, emphasizing the role of climate finance in fostering investments in clean energy to reduce CO2 emissions while sustaining economic growth. Leitão and Lorente (2020) explored this relationship within the European Union, focusing on the link between economic growth, renewable energy, tourism, trade openness, and CO2 emissions. Their research found that while trade openness and renewable energy contributed to reducing CO2 emissions, economic growth had a positive effect on emissions. This finding highlights the environmental trade-offs associated with economic expansion, even in regions committed to sustainability. The study advocates for integrating renewable energy and sustainable practices into growth strategies to mitigate the environmental impact of economic activities. In the context of Turkey, Karaaslan and Çamkaya (2022) investigated the effects of GDP, health expenditure, and energy consumption (both renewable and non-renewable) on CO2 emissions. Their findings revealed that GDP and non-renewable energy consumption were associated with higher CO2 emissions in both the short and long term, while health expenditure and renewable energy consumption were linked to lower emissions. The study underscores the importance of promoting renewable energy and health investments to reduce the environmental footprint of economic growth in Turkey.

The literature on the impact of CO2 emissions on economic growth reveals a complex and multifaceted relationship, with significant variations across different countries and regions. While economic growth has historically been associated with rising CO2 emissions, there is growing evidence that it is possible to decouple this relationship through the adoption of green technologies, energy efficiency measures, and supportive government policies. The challenge

lies in balancing the need for economic development with the imperative to protect the environment, particularly in developing countries where the trade-offs between growth and sustainability are most pronounced. As the global community continues to grapple with the challenges of climate change, the insights provided by these studies will be crucial in informing policies that promote sustainable economic growth while minimizing the environmental impact of CO2 emissions.

2.2.Domestic Investment and Economic Growth

Domestic investment plays a pivotal role in shaping economic growth, influencing an economy's productive capacity, and determining long-term development prospects. The relationship between domestic investment and economic growth is well-documented in economic literature, encompassing a range of theoretical models, empirical studies, and contextual factors. Understanding this relationship involves exploring various theoretical foundations, assessing empirical evidence, and examining the complexities associated with investment quality, efficiency, and policy integration. This literature review delves into these dimensions to provide a thorough analysis of how domestic investment affects economic growth.

The theoretical foundation for understanding the impact of domestic investment on economic growth is rooted in both classical and modern economic theories. Neoclassical growth theory, pioneered by Solow (1956) and Swan (1956), provides a fundamental framework for analyzing this relationship. According to the neoclassical model, investment in physical capital—such as machinery, infrastructure, and technology—directly enhances an economy's productive capacity. The model posits that an increase in investment leads to a rise in the capital stock, which, in turn, boosts output and productivity. The concept of diminishing returns is central to this theory, as it suggests that while additional investment initially stimulates growth, the rate of return on investment may decrease as the capital stock accumulates. This principle implies that the impact of further investment on economic growth diminishes over time, particularly as economies approach their optimal capital levels.

In contrast, endogenous growth theory, developed by Romer (1990) and Lucas (1988), offers a more nuanced perspective by incorporating the roles of human capital and technological innovation. Romer's model challenges the neoclassical assumption of diminishing returns by emphasizing the role of technological progress, driven by investments in research and

development (R&D). According to Romer (1990), technological advancement generates increasing returns to scale, leading to sustained economic growth. This model suggests that investments in R&D can create positive externalities that benefit the entire economy, fostering long-term growth. Similarly, Lucas (1988) highlights the importance of human capital investment, arguing that education and skill development enhance individual productivity and contribute to overall economic growth. The endogenous growth theory underscores the significance of not only physical capital but also human capital and technological innovation in driving economic development.

Empirical studies provide substantial evidence supporting the positive relationship between domestic investment and economic growth. One of the seminal works in this area is Barro and Sala-i-Martin's (1995) cross-country analysis, which reveals a robust connection between investment rates and economic growth. Their research indicates that countries with higher levels of domestic investment experience faster growth in GDP per capita. This finding aligns with the predictions of the neoclassical growth model, reinforcing the notion that investment in physical capital enhances productivity and output. Barro and Sala-i-Martin's (1995) study highlights the importance of capital accumulation in driving economic growth, particularly in the short to medium term.

Bakari (2020) explored the relationship between domestic investment and economic growth in Tunisia over the period from 1965 to 2016. Utilizing empirical strategies such as cointegration analysis, Vector Error Correction Models (VECM), and Granger causality tests, Bakari found a bidirectional negative relationship between domestic investment and long-term economic growth. This finding indicates that, within the Tunisian context, domestic investments have adverse effects on economic growth. Further investigations by Mkadmi et al (2021), Abdelhafidh and Bakari (2019), Bakari (2018a), Bakari et al (2018a), Bakari (2017a), Bakari (2017b), Bakari et al (2018b), and Bouchoucha and Bakari (2021), using similar models and time frames but with variations in control variables, have corroborated these results. These studies confirm that domestic investments tend to exert negative effects on economic growth in Tunisia. The consistency of these findings across multiple studies underscores the complex dynamics between investment and growth within the Tunisian economic context, highlighting the need for targeted policy measures to address these challenges.

Bakari (2024b) explores the relationship between domestic investments, exports, and economic growth in Australia. His study, using the Vector Error Correction Model (VECM), demonstrates

a positive long-term impact of domestic investments on GDP, with a 1% increase in investments correlating to a 0.11% increase in GDP. However, the relationship between exports and domestic investments was negative, suggesting that higher exports do not necessarily lead to increased domestic investment. Similarly, Bakari and El Weriemmi (2024) find a short-term bidirectional causality between domestic investment and economic growth in Arab countries, although no long-term relationship exists. Their findings emphasize the importance of domestic investment as a short-term engine of growth in these economies but highlight the need for more effective investment policies. Bakari (2023) further examines the MENA region, considering the role of unemployment. The study confirms that while domestic investment positively affects economic growth, high unemployment negatively impacts this relationship, stressing the need for policies that address both investment and labor market issues.

In contrast, Yedder et al (2023a) reveal no apparent impact of domestic investments and exports on Angola's economic growth, challenging conventional economic paradigms and suggesting a reassessment of existing policies. Bakari (2024c) extends this discussion to Latin America and the Caribbean, showing that domestic investments and financial development positively influence economic growth, though corruption control has minimal impact. This underscores the importance of policies promoting investment and financial development while addressing corruption. Yedder et al (2023b) also explore the impact of innovation and R&D on economic growth in MENA countries, finding that domestic investments foster growth but that insufficient R&D investment limits the benefits of innovation. In developed countries, Bakari (2022b) finds that exports positively affect the relationship between domestic investment and economic growth, while Bakari et al (2020a) reveal no significant impact of domestic investment, exports, and imports on Peru's growth, pointing to structural issues in economic organization. Othmani et al (2023) find no long-term causal relationship between patents, domestic investments, and economic growth in the USA, although short-term causation from investments to patents is noted.

In Albania, Akermi et al (2024) identify no significant long-term or short-term causality between domestic investment and economic growth, highlighting urgent needs for economic reforms. Bakari (2022c) also shows that in Greece, domestic investment and exports do not contribute to economic growth in the long run, while Bakari (2021a) finds that domestic investments are a key driver of growth in Spain, emphasizing the need for policies to enhance exports and improve the trade balance. Lastly, Bakari et al (2020b) suggest that taxation and domestic investment positively impact economic growth in Germany, indicating the complex

interplay between taxation policies and investment dynamics. Research by Bakari et al (2019a) on Uruguay highlights that domestic investment had no significant effect on economic growth over the period from 1960 to 2017. Their findings indicate that Uruguay's weak saving rate diminished the effectiveness of domestic investment, suggesting that stronger saving policies could enhance its impact on economic growth. In contrast, Bakari (2021b) examined the G7 countries and found that domestic investment positively influences economic growth, irrespective of the Internet's presence. This study suggests that domestic investment remains a robust driver of economic growth, unaffected by technological factors. Bakari and Tiba (2019a) investigated the determinants of economic growth in the USA from 1970 to 2016. Their analysis revealed that domestic investment, alongside final consumption expenditure, population growth, foreign direct investment inflows, and exports, contributed significantly to long-term economic growth. However, these variables had no short-term effects, underscoring the importance of domestic investment for sustained growth.

In France, Bakari (2018b) found a negative relationship between tax revenue, domestic investment, and economic growth over the period 1972-2016. This suggests that France's tax policies might undermine domestic investment and hinder economic growth, calling for immediate policy reforms to address these issues. Fakraoui and Bakari (2019) focused on India and observed that domestic investment did not significantly contribute to economic growth in the long run. Instead, exports were identified as a key driver of short-term economic growth, indicating that India's economic strategies might need to be reassessed to better leverage domestic investment. Research by Bakari (2017c) on Japan showed that domestic investment, along with exports, significantly contributed to economic growth from 1970 to 2015. This contrasts with the negligible impact of imports on economic growth, highlighting the importance of domestic investment and exports in Japan's economic development. In Nigeria, Bakari et al (2018c) found no long-term relationship between domestic investment, foreign direct investment, exports, imports, and economic growth from 1981 to 2015. However, short-term analysis indicated that imports and domestic investment had significant effects on economic growth, suggesting the need for urgent economic reforms.

Bakari et al (2021b) examined Brazil and found that in the short run, domestic investment, exports, and imports all contributed to economic growth. In the long run, domestic investment and exports positively affected economic growth, while imports had a negative impact. This study underscores the importance of balancing domestic investment and exports while managing imports for sustained economic growth in Brazil. Bakari (2017d) analyzed Sudan

and found no long-term relationship between domestic investment, exports, imports, and economic growth. In the short run, economic growth was found to cause domestic investment, indicating that while Sudan's economic strategies may need improvement, domestic investment still plays a role in short-term economic dynamics. In Gabon, Bakari (2017f) investigated the effects of exports and domestic investment on economic growth using data from 1980 to 2015. The study found that while both exports and investment positively influence economic growth in the short term, they have a negative impact in the long run. This suggests that although these factors are crucial for short-term economic stimulation, they are not effectively managed to sustain long-term growth. The findings highlight the need for improved policies to enhance the effectiveness of these economic drivers in Gabon. Bakari (2018c) examined the case of Algeria, where domestic investment showed a negative effect on economic growth in the long run, based on data from 1969 to 2015. In the short run, however, domestic investment was found to spur economic growth. This dual impact indicates that while domestic investment can be a catalyst for growth in the short term, structural and strategic issues hinder its long-term effectiveness in Algeria.

Similarly, Bakari (2017g) analyzed Malaysia's economic performance and found that domestic investment, along with exports and labor, positively affects economic growth in the long run. However, there was no short-term relationship between domestic investment and economic growth. This suggests that while domestic investment is a long-term driver of growth in Malaysia, its immediate effects are less pronounced, indicating a need for strategies to harness its short-term potential. In Canada, Bakari (2016a) explored the impact of domestic investment on economic growth from 1990 to 2015. The study found a weak relationship between domestic investment and economic growth in the short term, with no significant long-term connection. The lack of a causal relationship suggests that domestic investment alone may not be sufficient to drive economic growth in Canada, emphasizing the need for complementary policies and strategies.

The role of investment in human capital has also been extensively studied. Mankiw et al (1992) expanded the neoclassical model by incorporating human capital, demonstrating that investment in education significantly contributes to economic growth. Their research shows that countries with higher levels of educational attainment and skill development tend to achieve faster economic growth. This supports the endogenous growth theory’s emphasis on the role of human capital in driving productivity and innovation. Mankiw et al. (1992) find that educational investments lead to improvements in labor productivity, which, in turn, boosts

overall economic performance. The quality and efficiency of domestic investment are critical factors influencing its impact on economic growth. Mauro and Sussman (2001) explore the role of institutional quality in determining the success of investment projects. Their study highlights that countries with strong institutions and effective governance structures are better positioned to leverage domestic investment for economic growth. In contrast, countries with weak institutional frameworks may experience lower returns on investment due to inefficiencies and mismanagement. This perspective emphasizes that the effectiveness of investment is not solely a function of its magnitude but also its quality and the institutional environment in which it occurs.

Despite the overall positive relationship between domestic investment and economic growth, several challenges and limitations need to be addressed. One significant issue is the phenomenon of diminishing returns to investment. As noted by Mankiw et al (1992), while investment initially stimulates growth, the benefits may decrease over time as economies approach their optimal capital stock. These diminishing returns effect is particularly relevant in high-income countries where capital accumulation alone may not suffice to sustain high growth rates. In these economies, additional investment may yield progressively smaller increments in output, necessitating complementary strategies to sustain growth.

In developing countries, however, the potential for higher returns on investment exists due to lower initial levels of capital and infrastructure. Research by Aschauer (1989) and Easterly and Rebelo (1993) highlights that investment in infrastructure and basic services in developing economies can lead to significant improvements in productivity and economic growth. For example, improvements in transportation infrastructure can reduce transaction costs and enhance market accessibility, fostering economic activity. However, developing countries often face challenges such as inadequate institutional frameworks and limited access to financing, which can affect the effectiveness of investment. Aschauer (1989) emphasizes that investment in public infrastructure, such as roads and utilities, can yield substantial economic benefits by facilitating economic activities and improving productivity.

The impact of domestic investment is also influenced by broader economic policies and external factors. The World Bank (2017) underscores the importance of aligning domestic investment strategies with comprehensive economic policies and international trade agreements. Effective investment policies that integrate with trade and financial reforms can enhance the growth impact of domestic investment by improving market access, facilitating capital flows, and

promoting economic stability. For instance, trade liberalization can create new opportunities for investment by expanding market access and encouraging competition, while financial reforms can improve the efficiency of capital allocation and investment outcomes.

Moreover, the interaction between domestic investment and other economic variables, such as trade openness and macroeconomic stability, plays a crucial role in determining the overall impact on growth. Research by Copeland and Taylor (2004) explores the effects of trade openness on investment and growth, suggesting that open economies are better positioned to attract both foreign and domestic investment, leading to higher growth rates. Conversely, economic instability and policy uncertainty can undermine investment efforts and hinder growth prospects. This highlights the need for a holistic approach to investment policy that considers the broader economic environment and integrates with other economic strategies.

The relationship between investment, particularly public investment, and economic growth has been widely studied across various contexts, with mixed results. Ghani and Din (2006) focus on Pakistan, highlighting that while private investment significantly drives economic growth, the effects of public investment and consumption are less clear. Similarly, in South Africa, Ncanywa and Masoga (2018) find that public debt, used to finance public investment, has a long-term inverse relationship with economic growth, suggesting that excessive public borrowing can hinder rather than stimulate growth. In the context of education, Kuhl-Teles and Andrade (2008) argue that public investment in basic education can enhance human capital and promote economic growth, though its effectiveness is contingent on budget constraints. Nazmi and Ramirez (1997) examine Mexico and find that both public and private investments positively influence economic growth, but public investment also tends to crowd out private investment.

Sturm et al (1998) provide a broader review, noting that declining public investment in OECD countries during the 1970s and 1980s coincided with efforts to manage rising debt, which potentially impacted economic competitiveness. Munnell (1992) discusses similar themes in the U.S., where declining public capital investment was linked to reduced productivity growth, although the causality remains debated. Rabnawaz and Jafar (2015) explore the bi-directional relationship between GDP and public investment in Pakistan, finding that growth and public investment are mutually reinforcing. In Mexico, Sánchez-Juárez and García-Almada (2016) demonstrate that public debt has facilitated public investment, which in turn supports economic growth, albeit with diminishing returns. In Latin America, Ramirez and Nazmi (2003) confirm

that both public and private investments contribute to growth, emphasizing the positive role of public expenditures on education and healthcare in long-term economic performance. Milbourne et al (2003), using an augmented Solow-Swan model, find that while public investment contributes to economic growth in transition periods, its impact is statistically insignificant in steady-state models.

The literature on the impact of domestic investment on economic growth provides a multifaceted understanding of how investment drives economic development. Theoretical frameworks, including neoclassical and endogenous growth theories, offer valuable insights into the mechanisms through which investment influences growth. Empirical studies confirm the positive relationship between investment and growth, while also highlighting the importance of investment quality and institutional factors. Challenges such as diminishing returns and varying impacts in different contexts further underscore the complexity of this relationship. The integration of domestic investment strategies with broader economic policies and external factors is crucial for maximizing growth outcomes. Overall, the literature emphasizes the need for targeted investment strategies that consider both the potential benefits and challenges associated with domestic investment, offering valuable guidance for policymakers and practitioners seeking to foster sustainable economic growth.

2.3.Trade and Economic growth

Trade openness, encompassing both exports and imports, has been extensively studied in the context of economic growth. Numerous empirical studies have examined the dynamic relationship between trade openness and economic growth, highlighting both the potential benefits and challenges associated with increased integration into the global economy. The theoretical foundation for the positive impact of trade openness on economic growth is rooted in classical and neoclassical economic theories, which suggest that trade allows countries to specialize in the production of goods and services in which they have a comparative advantage, thereby improving efficiency and fostering economic growth. This idea is supported by the Heckscher-Ohlin model, which posits that countries export goods that utilize their abundant factors of production and import goods that require factors in which they are relatively scarce. This specialization enhances productivity, leading to higher economic growth.

Empirical studies have provided substantial evidence supporting the positive impact of trade openness on economic growth. For instance, Frankel and Romer (1999) conducted a seminal

study that used geographic instruments to show that trade has a significant positive effect on income per capita. Their research found that a one-percentage point increase in trade as a share of GDP raises income per capita by at least 0.5%. This study has been widely cited in the literature and has sparked further research on the topic. Similarly, Sachs and Warner (1995) identified a strong correlation between trade openness and economic growth in their cross-country analysis, concluding that open economies tend to grow faster than closed economies. They argued that trade openness facilitates access to advanced technologies, encourages competition, and allows countries to benefit from economies of scale, all of which contribute to economic growth.

However, the relationship between trade openness and economic growth is not universally positive. Some studies have highlighted the potential risks associated with increased trade openness, particularly for developing countries. Rodriguez and Rodrik (2001) questioned the robustness of the positive relationship between trade openness and growth, arguing that the impact of trade on growth is contingent on a variety of factors, including the quality of institutions, macroeconomic stability, and the level of human capital. They suggested that in the absence of these preconditions, trade openness could lead to adverse outcomes, such as increased income inequality and economic instability. This perspective has been supported by later studies, such as that of Stiglitz (2002), who argued that while trade liberalization can lead to economic growth, it can also exacerbate poverty and inequality if not accompanied by appropriate social and economic policies.

In addition to these considerations, the impact of trade openness on economic growth may vary depending on the composition of trade. Studies have shown that the effects of exports and imports on economic growth are not symmetric. For instance, export-led growth strategies have been widely successful in East Asian economies, where the expansion of exports, particularly in high-tech and manufacturing sectors, has driven rapid economic growth. Balassa (1978) and Feder (1983) were among the early proponents of the export-led growth hypothesis, which posits that exports contribute to economic growth by providing foreign exchange, enabling the import of capital goods, and facilitating technology transfer. On the other hand, the impact of imports on economic growth can be more complex. While imports of capital goods and intermediate inputs can enhance productivity and stimulate growth, excessive reliance on imports, particularly of consumer goods, can lead to trade deficits and hinder economic growth, as noted by Krugman (1994).

Recent studies have also emphasized the role of global value chains (GVCs) in shaping the relationship between trade openness and economic growth. The fragmentation of production across borders has created opportunities for countries to participate in GVCs, allowing them to specialize in specific stages of production and integrate into the global economy. Baldwin (2011) highlighted the significance of GVCs in explaining the positive relationship between trade openness and economic growth, particularly for developing countries that have successfully integrated into these chains. However, the benefits of GVC participation are not guaranteed, as countries that are confined to low-value-added segments of the chain may experience limited growth benefits, as pointed out by Gereffi and Fernandez-Stark (2016).

Farahane and Heshmati (2020) explored the Southern African Development Community (SADC) and found that while export expansion stimulated growth, increased trade openness reduced it, suggesting that the region may not fully benefit from trade liberalization due to incomplete implementation of key economic policies. This indicates that for SADC, more strategic trade policies focused on exports could better drive economic growth. Singh and Siddiqui (2023) examined the interplay between trade, innovation, and ICT in both developed and developing countries. Their findings showed a significant relationship between trade and economic growth in developed nations, but a weaker link in developing countries, highlighting the different roles trade openness plays in varying economic contexts. Intisar et al. (2020) provided insights into Asian countries, revealing that trade openness positively influences economic growth, particularly when coupled with human capital development. This suggests that in regions like Asia, trade policies need to be supported by investments in human capital to maximize growth benefits. Oppong-Baah et al. (2022) focused on Ghana and Nigeria, demonstrating that trade openness positively impacts economic growth, but with significant variation in the effects of other economic factors like inflation and exchange rates. This underlines the importance of considering multiple economic variables when assessing the impact of trade on growth. Wang and Zhang (2021) investigated the global effects of trade openness, particularly its impact on decoupling carbon emissions from economic growth. Their results indicated that trade openness contributes positively to economic growth while also aiding environmental sustainability in high-income countries but has mixed effects in lower-income nations.

Bunje et al. (2022) studied the African continent and found a complex relationship between trade openness and economic growth, with positive effects seen primarily through exports. Their findings suggest that trade policies in Africa should emphasize export growth to harness

the benefits of trade openness for economic development. Farahmand and Esen (2020) analyzed Afghanistan, revealing a bidirectional causality between trade openness and economic growth. Their study confirmed that exports drive growth, but the reverse is also true, emphasizing the importance of a balanced trade strategy. Hdom and Fuinhas (2020) explored Brazil and found that while trade openness supports economic growth, it also contributes to increased CO2 emissions, presenting a trade-off between growth and environmental sustainability. This calls for careful consideration of environmental policies alongside trade liberalization efforts. Tah et al. (2021) studied South Africa and confirmed that trade openness significantly promotes economic growth in both the short and long term, particularly when supported by human and physical capital. This underscores the need for comprehensive policies that integrate trade with broader economic development strategies.

Bakari (2024d) examined 17 East Asia-Pacific countries and found that trade openness, along with capital and labor, plays a crucial role in driving economic growth. This study suggests that while digitalization and natural resources have limited impacts, trade openness remains a significant factor in enhancing economic performance. Similarly, Bakari et al. (2022) explored the impact of trade openness and digitalization in the richest Asian countries, concluding that trade openness contributes positively to economic growth due to its association with technology transfer, financial capacities, and large market sizes. In contrast, Bakari and Saaidia (2018) found no significant effect of exports and imports on economic growth in Italy, highlighting the inefficacy of the economic strategies employed by the country. However, Bakari et al. (2019b) discovered a positive effect of exports on economic growth in China, although imports had a negative impact. This suggests that while exports can drive growth, imports may hinder it under certain conditions. Studies focusing on African and Middle Eastern countries provide further insight. Bakari (2021c) found a bidirectional positive relationship between exports and economic growth in African countries, while Bakari (2019) noted a causal effect from economic growth to exports in Morocco, indicating that economic growth drives exports rather than the other way around. In Tunisia, Bakari (2017i) found that while exports negatively impact long-term growth, imports have a positive effect, indicating that trade openness has complex effects on the economy, with imports playing a more beneficial role. In other regions, such as Germany and Canada, Bakari's research (2016b; 2017h) revealed that both exports and imports are significant drivers of economic growth, with evidence of bidirectional causality. Conversely, in Turkey and Mauritania, while imports positively influenced growth, exports did not show a significant effect, as noted by Bakari and Mabrouki (2016) and Bakari and Krit (2017).

Dragusha et al. (2023) analyzed the impact of trade liberalization on Albania's economic growth, revealing a positive relationship between trade openness and GDP growth. The study highlighted that trade liberalization enhances both exports and imports, contributing to overall economic development. Similarly, in the context of Asian countries, Yang and Shafiq (2020) found that trade openness, along with FDI and capital formation, positively correlates with economic growth. The fixed-effects model employed in their study underscored the robustness of this relationship, even when accounting for other macroeconomic variables such as inflation and money supply. In the ASEAN region, Ho et al. (2021) examined the interplay between financial development, trade openness, and economic growth. Their findings suggest that trade openness not only fosters economic growth but also strengthens the relationship between financial development and growth. This bidirectional causality underscores the critical role of trade policies in enhancing the economic performance of ASEAN countries. Furthermore, in developing countries, Ho et al (2023) identified a positive relationship between tax revenue and economic growth, which is amplified by increased trade openness. However, they caution that excessive openness could diminish this positive effect, suggesting an optimal level of trade openness for maximizing economic benefits.

Focusing on Sub-Saharan Africa, Akinlo and Okunlola (2021) explored the interaction between trade openness, institutional quality, and economic growth. Their research revealed that while high-quality institutions are essential for realizing the benefits of trade openness, variables such as corruption and bureaucratic inefficiency can undermine these benefits. Conversely, in Nigeria, Nwadike et al (2020) established a significant positive impact of trade openness on economic growth, further emphasizing the long-run stability of this relationship. Their study underscores the need for conducive trade policies to attract investment and stimulate economic growth. In China, Kong et al. (2021) examined how trade openness affects the quality of economic growth, finding that it significantly enhances growth quality both in the short and long term. The study highlighted regional disparities and the non-linear nature of this relationship, suggesting that different regions may experience varying impacts from trade openness. Similarly, in the EU-28, Balsalobre-Lorente and Leitão (2020) found that trade openness, alongside renewable energy use and tourism, positively contributes to economic growth. Their findings support the tourism-led growth hypothesis, indicating that trade policies promoting openness can simultaneously advance environmental sustainability and economic development. In North Africa, Sghaier (2023) focused on the relationship between trade openness, financial development, and economic growth. The study concluded that trade

openness significantly enhances economic growth in the region, especially when coupled with robust financial development. This finding aligns with earlier studies that emphasize the complementary role of financial systems in maximizing the benefits of trade openness.

Galvan et al. (2022) explore the impact of trade openness on CO2 emissions and economic growth in middle-income trap (MIT) countries in Latin America. They find that while trade positively influences GDP growth, its impact on CO2 emissions is more pronounced in higher-income countries, suggesting that trade can drive growth in MIT countries without severely affecting environmental quality. Ampofo et al. (2020) examine trade openness in top mineral-rich countries, revealing that positive shocks to trade openness generally enhance economic growth, especially in countries not afflicted by the 'resource curse.' Similarly, Gabriel and David (2021) analyze sub-Saharan African countries, showing that trade openness significantly boosts growth in low-income nations, though its effects are mixed in middle-income countries. In the context of Nigeria, Darazo and Adaramola (2021) highlight that international trade positively impacts long-term economic growth, emphasizing the role of exports in driving growth. Osadume and Uzoma (2020) also support the positive link between trade openness and economic development in Nigeria, particularly through maritime trade, which has a significant causal relationship with economic growth. Contrarily, Wani (2022) finds that in India, trade openness has a negative relationship with economic growth, suggesting that other factors, such as capital formation, may be necessary to realize the benefits of trade. Ben Abdallah (2023) studies MENA countries and concludes that trade openness, along with FDI, significantly promotes economic growth in the long term. Finally, Bonsu and Wang (2022) investigate the triangular relationship between energy consumption, trade openness, and economic growth, confirming a bidirectional relationship where trade openness contributes to growth but also increases energy consumption.

Osei-Assibey Bonsu and Wang (2022) examine the triangular relationship between trade openness, energy consumption, and economic growth in 45 countries from 1991 to 2014. Their findings suggest that trade openness has a significant long-term impact on economic growth, although this impact is less pronounced than the influence of energy consumption. This indicates that while trade openness contributes to economic growth, it is part of a broader set of factors that drive development. Similarly, Magai (2022) explores the role of trade and foreign direct investment (FDI) in Tanzania's economic growth. The study confirms a positive relationship between trade openness and economic growth, both in the short and long run. This underscores the importance of promoting exports to harness the growth potential of trade and

FDI in developing economies. Stamatiou et al (2021) investigate the relationship between trade, energy consumption, and economic growth in Greece. Their results highlight a bidirectional relationship between trade openness and economic growth, emphasizing the interconnected nature of trade policies and economic outcomes. The study suggests that Greece can benefit from trade by focusing on clean technologies and renewable energy, which also aligns with sustainable development goals.

Bakari (2017j) explores the intricate link between exports, imports, domestic investment, and economic growth in Egypt, using data from 1965 to 2015. The study employs Johansen co-integration analysis and the Vector Error Correction Model to discern both long-term and short-term relationships among these variables. The findings suggest that, in the long run, domestic investment and exports have a negative impact on economic growth, while imports contribute positively. Conversely, in the short run, imports are the primary drivers of economic growth. This nuanced understanding highlights the critical need for economic reforms in Egypt to better harness the benefits of trade and investment. In a broader context, Bakari and Tiba (2019b) analyze the impact of trade openness, foreign direct investment (FDI), and domestic investment on economic growth across 24 Asian developing countries from 2002 to 2017. Their research, utilizing fixed and random effects models, reveals that domestic investment has a positive effect on economic growth. However, foreign direct investment and exports appear to hinder growth. The study underscores the importance of positive externalities associated with trade openness and FDI, such as technology transfer, financial resources, and market size, which can enhance domestic capacities and foster economic development in these economies. Bakari (2017e) extends this discussion by examining the case of South Africa, a country rich in natural resources and industrial progress yet still classified as developing. This study investigates how domestic investment, exports, and imports impact South Africa's economic growth. The analysis indicates that despite the country's resources, imports pose a significant barrier to economic advancement, suggesting that overcoming this challenge is crucial for achieving sustained growth.

Wiredu et al (2020) focus on West African countries, finding that trade openness positively and significantly impacts economic growth. However, the study also notes that the effect of FDI is less pronounced, indicating that trade policies should be complemented by other economic strategies to maximize growth benefits. Dritsaki and Dritsaki (2020) analyze the Baltic countries, revealing that trade openness has a positive impact on economic growth, driven by innovation and productivity. The study emphasizes the importance of stable economic policies

to enhance the benefits of trade in these developing economies. Nguyen et al. (2020) explore East Asia, finding that trade balance is significantly influenced by exports and exchange rates. Although trade openness has a positive effect, its impact on economic growth is complex and intertwined with other economic factors, suggesting that trade policies need to be tailored to specific regional contexts. Acharya (2022) examines Nepal, showing that foreign trade significantly contributes to economic growth. The study highlights that trade openness is crucial for developing countries like Nepal, where increasing trade can lead to substantial economic benefits.

Soomro et al (2022) investigate BRICS countries, concluding that trade openness, along with ICT, plays a significant role in economic growth. However, the study also notes that the impact of trade openness on growth can be negative, depending on the economic structure and policies of the countries involved. Rahman et al (2020) focus on South Asia, where trade openness negatively affects economic growth, contrasting with the positive effects of CO2 emissions and population density. This suggests that trade policies in South Asia need to be reevaluated to better align with economic growth objectives. Finally, Khumoetsile and Kahaka (2022) and Safiyanu and Chua (2020) analyze Botswana and sub-Saharan Africa, respectively, finding that trade openness generally enhances economic growth. However, the studies also highlight the need for structural changes in trade policies to optimize growth outcomes, particularly in diversifying exports and reducing reliance on raw materials. Srdelić and Dávila-Fernández (2024) analyze Croatia's economic growth over the past two decades, highlighting its close connection to international trade dynamics. Their study employs a state-space model and Kalman smoother to estimate time-varying parameters of exports and imports, revealing that R&D investments and human capital are crucial for understanding international competitiveness and economic growth. The findings underscore the importance of these factors in predicting Croatia's long-term growth and the broader implications for EU integration. Nam et al (2024) explore the relationship between trade openness and income inequality within the Association of Southeast Asian Nations (ASEAN). Their study identifies an inverted U-shaped relationship, where initial increases in trade openness lead to higher income inequality, but this trend reverses beyond a certain threshold. Institutional quality is found to play a significant moderating role, with better governance and policies mitigating inequality and supporting economic growth. This highlights the dual role of trade openness in fostering growth while requiring strong institutions to ensure equitable benefits across society.

While trade openness is widely recognized as a driver of economic growth, its impact is not

universally positive and can be influenced by various economic, social, and institutional factors. The relationship is complex, with trade policies needing to be strategically tailored to specific contexts to maximize benefits and mitigate potential downsides. The evidence underscores the importance of a balanced approach to trade liberalization, one that integrates complementary policies, such as investments in human capital and environmental sustainability, to fully harness the growth potential of increased global integration.

3. Data and Methodology

In our empirical study, the primary objective is to analyze the impact of CO2 emissions, domestic investment, and trade openness on economic growth within the context of North African countries, specifically Egypt, Libya, Tunisia, Algeria, and Morocco. This investigation covers an extensive period from 1998 to 2022, utilizing data sourced from the annual reports published by the World Bank. The focus is on understanding how these variables interact and influence economic growth in this region, with particular attention to the dynamic relationships over the specified time frame.

To ensure a rigorous analysis, we begin by defining and transforming our variables. Economic growth, denoted by 'Y', is quantified using gross domestic product (GDP) at constant prices. This choice of measurement allows us to assess economic performance while controlling for inflationary effects. Domestic investment, represented by 'DI', is captured through gross fixed capital formation at constant prices, which reflects the level of investment in physical assets and infrastructure. Labor, indicated by 'L', is measured by the total active population, offering insight into the workforce available in each country. CO2 emissions, denoted as 'CO2', are expressed in kilotonnes, providing a quantifiable measure of carbon dioxide emissions produced by each country. To account for inflation and maintain consistency, exports and imports are represented by 'X' and 'M' respectively, with both variables measured by their values at constant prices. Transforming these variables into their logarithmic forms is a crucial step. This transformation helps stabilize the variance of the data, ensuring that the relationships between the variables are linear and more interpretable.

The empirical methodology of our study is structured into several distinct stages to ensure comprehensive and reliable results. The initial stage involves presenting descriptive statistics of the variables. This includes analyzing the maximum and minimum values observed over the study period. By doing so, we assess the variability and distribution of each variable, which is

essential for determining whether the data exhibit sufficient variation for panel data estimation. This preliminary analysis provides a foundation for understanding the range of values and the potential impact of each variable on economic growth.

Following the descriptive analysis, we move to the correlation analysis. This stage involves calculating and interpreting the correlation coefficients between the variables. We specifically examine whether any correlation coefficient exceeds a threshold of 60% (0.60). A high correlation suggests a strong relationship between variables, which supports the use of panel data methods for estimation. This analysis helps identify the strength and nature of the relationships among CO2 emissions, domestic investment, trade openness, and economic growth, guiding the selection of appropriate estimation techniques. The correlation coefficient (ρ) between two variables (X) and (Y) is given by:

$$\boldsymbol{\rho(X,Y) = \frac{Cov(X,Y)}{\sigma_X \sigma_Y}}$$

where $\mathrm{Cov}(X,Y)$ is the covariance between (X) and (Y), and (σ_X) and (σ_Y) are the standard deviations of (X) and (Y) respectively. We check if any correlation coefficient exceeds 0.60 to justify using panel data methods.

The third stage of our methodology involves estimating the impact using a static gravity model with fixed effects. The fixed effects model is designed to control for individual heterogeneity by accounting for time-invariant characteristics unique to each country. This approach allows us to isolate the effects of CO2 emissions, domestic investment, and trade openness on economic growth, mitigating potential biases that could arise from unobserved country-specific factors. The fixed effects model thus provides a robust framework for understanding how these variables influence economic growth while controlling for country-specific differences. The fixed effects model can be expressed as:

$$\boldsymbol{Ln(Y_{it}) = \beta_0 + \beta_1 Ln(DI_{it}) + \beta_2 Ln(CO2_{it}) + \beta_3 Ln(X_{it}) + \beta_4 Ln(M_{it}) + \alpha_i + \epsilon_{it}}$$

where:

- (β_0) is the intercept.
- ($\beta_1, \beta_2, \beta_3, \beta_4$) are the coefficients for domestic investment, CO2 emissions, exports, and imports, respectively.

- ✓ (α_i) represents the country-specific fixed effect, capturing time-invariant characteristics.

- ✓ (ϵ_{it}) is the error term.

In the subsequent stage, we apply a gravity model with random effects. The random effects model assumes that the unobserved individual effects are uncorrelated with the regressors. This model offers an alternative approach to estimating the relationships between variables, capturing the impact of CO2 emissions, domestic investment, and trade openness on economic growth while accounting for unobserved heterogeneity. The random effects model is useful for examining the overall impact of these variables when the assumption of uncorrelated errors holds. We also estimate using a random effects model, which assumes that the individual effects are uncorrelated with the regressors. The model is expressed as:

$$\mathbf{Ln(Y_{it}) = \beta_0 + \beta_1\, Ln(DI_{it}) + \beta_2\, Ln(CO2_{it}) + \beta_3\, Ln(X_{it}) + \beta_4\, Ln(M_{it}) + u_i + \epsilon_{it}}$$

Where (u_i) is the random effect component, assumed to be uncorrelated with the regressors, and (ϵ_{it}) is the error term.

The final stage in our empirical methodology is the Hausman test. This test is crucial for determining whether to use the fixed effects or random effects model. The Hausman test evaluates whether the unique errors are correlated with the regressors, which informs the choice between the two models. If the p-value of the Hausman test is below 5%, we prefer the fixed effects model, as it indicates that the fixed effects approach provides a more accurate estimation by controlling for potential endogeneity. Conversely, if the p-value is above 5%, the random effects model is selected, suggesting that the assumptions of the random effects model are more appropriate for our data. The Hausman test evaluates the discrepancy between the fixed effects and random effects estimators to check if the random effects assumption (that the individual effect is uncorrelated with the regressors) holds. The test statistic (H) is computed as follows:

$$\mathbf{H = \left(\widehat{\beta_{FE}} - \widehat{\beta_{RE}}\right)' \left[Var\left(\widehat{\beta_{FE}}\right) - Var\left(\widehat{\beta_{RE}}\right)\right]^{-1} \left(\widehat{\beta_{FE}} - \widehat{\beta_{RE}}\right)}$$

Where:

- ✓ ($\widehat{\beta_{FE}}$) is the vector of coefficients from the fixed effects model.

- ✓ ($\widehat{\beta_{RE}}$) is the vector of coefficients from the random effects model.

- ✓ $(\mathrm{Var}(\widehat{\beta_{FE}}))$ is the variance-covariance matrix of the fixed effects estimator.
- ✓ $(\mathrm{Var}(\widehat{\beta_{RE}}))$ is the variance-covariance matrix of the random effects estimator.

The Hausman test statistic (H) follows a chi-square distribution with degrees of freedom equal to the number of coefficients being tested. The p-value is computed as:

$$\textbf{p-value} = \mathbf{P}(\chi_{\mathrm{k}}^2 > \mathbf{H})$$

Where (k) is the number of coefficients in the model.

- ✓ If the p-value is less than 0.05, it suggests rejecting the null hypothesis that the random effects model is appropriate, implying that the fixed effects model is preferred.
- ✓ If the p-value is greater than 0.05, it indicates that the random effects model is appropriate as the assumptions of the random effects model hold.

This alternative notation provides a clear understanding of the Hausman test and its application in choosing between fixed effects and random effects models. By adhering to this well-defined and systematic methodology, we are able to undertake a detailed and precise analysis of the impact that CO2 emissions, domestic investment, and trade openness have on economic growth within North African countries. This approach is meticulously structured to ensure that each aspect of the data is rigorously examined, allowing us to capture the intricate dynamics between these variables and their collective influence on economic performance.

Our methodology involves several stages, beginning with the transformation and analysis of the data, followed by correlation assessments, and culminating in the application of advanced econometric models. By carefully evaluating both fixed effects and random effects models and employing the Hausman test to validate our model choice, we can confidently assess the validity and robustness of our findings. This comprehensive analytical framework not only enhances the accuracy of our results but also provides a deeper understanding of the factors driving economic growth in the region. The insights gained from this analysis are crucial for policymakers and stakeholders, as they offer evidence-based recommendations and highlight the key areas where interventions could have the most significant impact. Consequently, our study contributes valuable knowledge that can guide strategic decisions aimed at fostering sustainable economic development in North Africa.

4. Empirical Results

The empirical analysis of economic growth, domestic investment, labor, CO2 emissions, exports, and imports offers valuable insights into the dynamics shaping economic performance. By employing descriptive statistics and correlation analysis, we gain an initial understanding of the central tendencies and interrelationships among these key variables. Descriptive statistics provide a snapshot of the data distribution, while correlation analysis reveals the strength and direction of associations between economic growth and other factors. Furthermore, the estimation of static gravity models with fixed and random effects, complemented by the Hausman test, helps to identify the most appropriate model for analyzing the impact of these variables on economic growth. This section interprets the empirical results, highlighting the significance of each variable and the implications for economic policy and development.

4.1.Descriptive statistics and correlation analysis

Table 1 provides a comprehensive overview of the descriptive statistics and correlation analysis for the key variables under examination: economic growth ‘Ln(Y)’, domestic investment ‘Ln(DI)’, labor ‘Ln(L)’, CO2 emissions ‘Ln(CO2)’, exports ‘Ln(X)’, and imports ‘Ln(M)’. This table serves as a foundational element in understanding the characteristics and interrelationships of these variables, offering valuable insights into their collective impact on economic performance. Beginning with the descriptive statistics, we can derive a nuanced view of each variable's central tendencies and dispersion. For economic growth ‘Ln(Y)’, the mean value stands at 25.34820, accompanied by a standard deviation of 0.747566. This indicates that while there is a moderate degree of variability in economic growth over the sample period, the values tend to cluster around the mean. The median value of 25.42750, being quite close to the mean, suggests that the distribution of economic growth is relatively symmetric. The range of economic growth values spans from a minimum of 23.94967 to a maximum of 26.74481, underscoring the variability in economic performance observed within the dataset.

Domestic investment ‘Ln(DI)’ shows a mean of 23.87656 and a standard deviation of 0.800295. Here, the median value of 24.06337 is close to the mean, reflecting a nearly symmetric distribution of investment levels across the sample. The range of domestic investment values, from a minimum of 22.26499 to a maximum of 25.09020, highlights a noticeable degree of variability, pointing to diverse levels of investment across the observed entities. Labor ‘Ln(L)’ presents a mean of 16.13029 with a standard deviation of 0.715770. The median value of

16.21869 is relatively close to the mean, indicating a balanced distribution of labor availability around the average. The range, which extends from a minimum of 14.51802 to a maximum of 17.24716, illustrates some variation in labor force sizes.

Table 1: Results of descriptive statistics and correlation analysis

Descriptive Statistics						
	Ln (Y)	**Ln (DI)**	**Ln (L)**	**Ln (CO2)**	**Ln (X)**	**Ln (M)**
Mean	25.34820	23.87656	16.13029	11.16507	24.01760	24.15188
Median	25.42750	24.06337	16.21869	11.17024	24.09498	24.08472
Maximum	26.74481	25.09020	17.24716	12.40714	25.22673	25.46036
Minimum	23.94967	22.26499	14.51802	9.849005	22.93346	23.03251
Std. Dev.	0.747566	0.800295	0.715770	0.783214	0.545820	0.579110
Skewness	-0.045521	-0.397444	-0.190233	-0.025733	-0.080455	0.173325
Kurtosis	2.028795	2.020637	2.154423	1.639630	2.011288	2.206468
Correlation Analysis						
	Ln (Y)	**Ln (DI)**	**Ln (L)**	**Ln (CO2)**	**Ln (X)**	**Ln (M)**
Ln (Y)	1					
Ln (DI)	0.919	1				
Ln (L)	0.945	0.833	1			
Ln (CO2)	0.978	0.924	0.883	1		
Ln (X)	0.808	0.861	0.693	0.799	1	
Ln (M)	0.871	0.869	0.783	0.831	0.843	1

For CO2 emissions ‘Ln(CO2)’, the mean is 11.16507, with a standard deviation of 0.783214. The median value, almost identical to the mean at 11.17024, reflects a symmetric distribution of emissions within the dataset. The range of CO2 emissions values, from a minimum of 9.849005 to a maximum of 12.40714, further emphasizes the variability in environmental impacts associated with economic activities. Exports ‘Ln(X)’ exhibit a mean of 24.01760 and a standard deviation of 0.545820. The median value of 24.09498 being close to the mean suggests a balanced distribution of export levels. The range of export values, from 22.93346 to 25.22673, indicates a moderate level of variation in export activities. Imports ‘Ln(M)’ show a mean of 24.15188, with a standard deviation of 0.579110. The median value of 24.08472 aligns closely with the mean, suggesting a symmetric distribution. The range of import values, from 23.03251 to 25.46036, reveals variability in import levels, similar to exports.

Turning to the correlation analysis, several notable relationships between the variables emerge. The correlation coefficient between economic growth 'Ln(Y)' and domestic investment 'Ln(DI)' is 0.919, reflecting a very strong positive association. This indicates that higher levels of domestic investment are closely linked with increased economic growth. Similarly, the correlation between economic growth and labor 'Ln(L)' is 0.945, suggesting an even stronger positive relationship. This high correlation implies that increases in the labor force are highly associated with higher economic output, underscoring the critical role of labor in driving economic performance. The relationship between economic growth and CO2 emissions 'Ln(CO2)' is the strongest among the correlations presented, with a coefficient of 0.978. This extremely high positive correlation suggests that economic growth is closely tied to higher levels of CO2 emissions, reflecting the environmental costs associated with economic activities. Exports 'Ln(X)' show a positive correlation with economic growth of 0.808, indicating a strong association. This suggests that increases in export activities contribute positively to economic growth. Imports 'Ln(M)' also exhibit a strong positive correlation with economic growth at 0.871, implying that higher import levels are similarly associated with increased economic output.

4.2.Estimation of the static gravity model with fixed effect

Table 2 presents the findings from the estimation of the static gravity model with fixed effects, which serves to account for the time-invariant characteristics of countries that might influence economic growth. By incorporating these fixed effects, the model aims to provide a more accurate assessment of how various explanatory variables impact economic growth, isolating their effects from those that are constant over time for each country. The coefficient for domestic investment 'Ln(DI)' stands at -0.064831, accompanied by a t-statistic of -2.756559 and a p-value of 0.0076. This negative coefficient is both surprising and significant, suggesting an inverse relationship between domestic investment and economic growth. Specifically, the result implies that, contrary to the conventional expectation that higher domestic investment should spur economic growth, an increase in investment is associated with a decrease in economic growth within the context of this model. This counterintuitive finding could reflect several underlying issues, such as inefficiencies in investment allocation or diminishing returns on investment, which are not uncommon in economic studies and warrant further investigation.

In contrast, the coefficient for labor 'Ln(L)' is 0.475134, with a t-statistic of 15.93518 and a p-value of 0.0000. This coefficient is both positive and highly significant, indicating a strong and

positive relationship between labor and economic growth. The high t-statistic and the very low p-value underscore the robustness of this result, suggesting that increases in the labor force are strongly associated with higher economic output. This finding aligns with the theoretical understanding that a larger workforce can drive greater production and economic activity, underscoring the critical role of labor in economic performance.

Table 2: Results of the estimation of the static gravity model with fixed effect

Dependent Variable: Ln (Y)				
Static Gravity Model : Fixed Effect				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	12.17525	0.781286	15.58359	0.0000
Ln (DI)	-0.064831	0.023519	-2.756559	0.0076
Ln (L)	0.475134	0.029817	15.93518	0.0000
Ln (CO2)	0.570105	0.023502	24.25735	0.0000
Ln (X)	0.103663	0.024852	4.171292	0.0001
Ln (M)	-0.074452	0.058904	-1.263961	0.2108

The CO2 emissions 'Ln(CO2)' coefficient is 0.570105, supported by a t-statistic of 24.25735 and a p-value of 0.0000. This positive and statistically significant coefficient highlights a strong relationship between CO2 emissions and economic growth. Specifically, it indicates that higher levels of CO2 emissions are closely linked with increased economic output. This result emphasizes the environmental trade-offs associated with economic growth, reflecting the often-high environmental costs incurred as economies expand.

For exports 'Ln(X)', the coefficient is 0.103663, with a t-statistic of 4.171292 and a p-value of 0.0001. This positive and significant result indicates that increases in exports are positively associated with economic growth. The statistically significant coefficient reinforces the notion that trade, through exports, plays a crucial role in driving economic performance, highlighting the importance of international trade as a driver of economic expansion. In contrast, the coefficient for imports 'Ln(M)' is -0.074452, with a t-statistic of -1.263961 and a p-value of 0.2108. This coefficient is not statistically significant, suggesting that the effect of imports on economic growth is not substantial within the fixed effects model. The lack of significance indicates that, contrary to exports, imports do not have a clear or significant impact on economic growth in the context of this model, potentially reflecting that their effects are overshadowed by other variables or that their impact varies in different contexts.

Overall, the results from Table 2 provide a nuanced understanding of how domestic investment, labor, CO2 emissions, exports, and imports influence economic growth when accounting for time-invariant country-specific factors. While labor and CO2 emissions show a significant positive relationship with economic growth, the unexpected negative impact of domestic investment and the lack of significance for imports highlight areas for further research and analysis.

4.3.Estimation of the static gravity model with random effect

Table 3 presents the results of the static gravity model with random effects, a methodological approach that offers a distinct perspective on the influence of various variables on economic growth. Unlike the fixed effects model, which accounts for time-invariant characteristics specific to each country, the random effects model assumes that these individual-specific effects are uncorrelated with the explanatory variables. This assumption provides a different lens through which to assess the impact of domestic investment, labor, CO2 emissions, exports, and imports on economic growth.

The coefficient for domestic investment 'Ln(DI)' in the random effects model is -0.067292, with a t-statistic of -2.926399 and a p-value of 0.0044. This negative coefficient suggests that, similar to the fixed effects model, higher levels of domestic investment are associated with lower economic growth. The statistical significance of this result, with a p-value below the conventional threshold of 0.05, indicates that this finding is unlikely to be due to random chance. This persistent negative relationship across both models suggests that there may be underlying inefficiencies or diminishing returns associated with domestic investment, warranting further investigation into how investments are allocated and utilized within the economies studied.

For 'labor 'Ln(L)', the coefficient is 0.364929, with a t-statistic of 20.77143 and a p-value of 0.0000. This positive and highly significant result underscores a robust relationship between the labor force and economic growth. The positive coefficient suggests that an increase in the labor force is strongly associated with higher GDP growth, consistent with the fixed effects model. This result reinforces the critical role of labor as a driver of economic performance, indicating that expanding the workforce can significantly contribute to enhancing economic output. The coefficient for CO2 emissions 'Ln(CO2)' is 0.566262, with a t-statistic of 24.99820 and a p-value of 0.0000. This result reveals a significant positive relationship between CO2

emissions and economic growth, highlighting the high environmental impact associated with increased economic activity. The consistency of this finding across both the fixed and random effects models suggests that economic growth is closely linked with higher CO2 emissions, pointing to the need for strategies that balance economic development with environmental sustainability.

Table 3: Results of the estimation of the static gravity model with random effect

Dependent Variable: Ln (Y)				
Static Gravity Model : Random Effect				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	9.229544	0.376297	24.52728	0.0000
Ln (DI)	-0.067292	0.022995	-2.926399	0.0044
Ln (L)	0.364929	0.017569	20.77143	0.0000
Ln (CO2)	0.566262	0.022652	24.99820	0.0000
Ln (X)	0.062517	0.022590	2.767425	0.0069
Ln (M)	0.166243	0.022255	7.469851	0.0000

For exports ‘Ln(X)’, the coefficient is 0.062517, with a t-statistic of 2.767425 and a p-value of 0.0069. This positive and statistically significant result indicates that higher levels of exports are associated with increased economic growth, though the effect is less pronounced compared to the fixed effects model. This finding suggests that while exports contribute positively to economic growth, the magnitude of their impact is somewhat reduced in the random effects model. This difference may reflect variations in how exports influence economic growth under different modeling assumptions.

The coefficient for imports ‘Ln(M)’ is 0.166243, with a t-statistic of 7.469851 and a p-value of 0.0000. This result shows a strong positive relationship between imports and economic growth, indicating that increased imports are significantly associated with higher economic output in the random effects model. The high t-statistic and low p-value highlight the robustness of this finding, suggesting that imports play a crucial role in boosting economic growth, possibly by providing access to additional resources and inputs that enhance production and efficiency.

Overall, the results from Table 3 offer valuable insights into the dynamics of economic growth under the random effects model. While some variables, such as labor and CO2 emissions, show

consistent effects across both fixed and random effects models, others like domestic investment and exports exhibit variations in their impact. These findings highlight the importance of considering different modeling approaches to fully understand the complex relationships between economic variables and growth.

4.4.Hausman test

Table 4 details the results of the Hausman test, a statistical procedure essential for deciding between the fixed effects and random effects models in panel data analysis. This test evaluates whether the individual-specific effects—unique characteristics or attributes of each entity in the dataset that remain constant over time—are correlated with the explanatory variables included in the model. The outcome of this test has significant implications for selecting the appropriate modeling approach, as it influences the reliability of the estimated effects of variables like domestic investment, labor, CO2 emissions, exports, and imports on economic growth.

The Chi-Square Statistic reported in the test is 32.683682, accompanied by 5 degrees of freedom. This statistic measures the extent of the discrepancy between the fixed effects and random effects estimators, based on whether or not the null hypothesis—asserting that the individual-specific effects are uncorrelated with the explanatory variables—can be rejected. In this case, the test statistic is notably high, indicating a substantial difference between the estimates produced by the two models. The p-value associated with this Chi-Square Statistic is 0.0000, which is significantly below the conventional threshold of 0.05. This extremely low p-value provides strong evidence against the null hypothesis. It suggests that the individual-specific effects are indeed correlated with the explanatory variables. Consequently, the random effects model, which assumes no correlation between individual-specific effects and the regressors, would yield biased and inconsistent estimates under these conditions.

Table 4: Results of the Hausman test

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Period random	32.683682	5	0.0000

Given this outcome, the test strongly supports the use of the fixed effects model over the random effects model. The fixed effects model is designed to control for such correlations by accounting for individual-specific characteristics that may influence the dependent variable, thereby providing more reliable and accurate estimates of the effects of explanatory variables on economic growth. By incorporating these individual-specific effects, the fixed effects model

adjusts for potential biases that could otherwise skew the analysis if the random effects model were employed.

The Hausman test results underscore the appropriateness of the fixed effects model for this dataset. The significant Chi-Square Statistic and the near-zero p-value collectively indicate that individual-specific effects are correlated with the explanatory variables, validating the need for a fixed effects approach. This model is more suitable for capturing the true impact of domestic investment, labor, CO2 emissions, exports, and imports on economic growth, ensuring that the estimates reflect the underlying relationships without the distortion that might arise from using the random effects model.

5. Conclusions and recommendations

This paper aims to explore the complex interactions between CO2 emissions, domestic investment, and trade openness in influencing economic growth within North African countries over the period from 1998 to 2022. Using a panel static gravity model, the study provides a nuanced understanding of how these factors contribute to economic performance, offering valuable insights for policymakers and economic planners in the region.

The analysis reveals that domestic investment, contrary to common expectations, has a negative impact on economic growth. This finding suggests that increases in domestic investment may not necessarily translate into enhanced economic performance in the North African context. Several interpretations could explain this counterintuitive result. One possibility is that domestic investment might be misallocated or insufficiently productive, failing to generate the anticipated growth benefits. It could also indicate that the economic environment in North African countries might not be conducive to maximizing the returns from such investments, possibly due to structural inefficiencies or other impediments.

On the other hand, the study finds a positive relationship between CO2 emissions and economic growth. This result underscores the paradox of economic development in many regions, where increased economic activity, often reflected by higher CO2 emissions, contributes to growth. However, this positive association also highlights the environmental trade-offs involved, as higher CO2 emissions signal increased industrial activity and consumption that might come at the cost of environmental degradation. The positive impact of CO2 emissions on economic growth thus suggests the need for a balanced approach that fosters economic development while mitigating environmental impacts.

Exports are also shown to positively contribute to economic growth in North Africa. This finding reinforces the critical role of trade openness in driving economic performance. Increasing exports can enhance economic growth by expanding market opportunities, fostering competitive industries, and generating foreign exchange earnings. The result highlights the importance of policies that support and promote export activities, such as improving trade infrastructure, reducing export barriers, and encouraging product diversification.

In contrast, the study reveals that imports negatively affect economic growth, although this effect is not statistically significant. This result suggests that while imports might exert some negative pressure on economic growth, the impact is not strong enough to be considered a major hindrance. The negative effect could stem from factors such as increased competition for domestic industries or trade imbalances that adversely affect local economic conditions. However, the insignificance of this result implies that the impact of imports is relatively mild compared to other variables like exports and CO2 emissions.

The value added by this study lies in its comprehensive examination of the interplay between CO2 emissions, domestic investment, and trade openness within the specific context of North African countries. By highlighting the differential effects of these factors on economic growth, the research provides targeted recommendations for policymakers. It suggests that fostering an export-oriented economic strategy while addressing the environmental consequences of CO2 emissions could offer a pathway to sustainable growth. Additionally, it points to the need for careful management of domestic investment and imports to maximize their contributions to economic development. The study contributes to a deeper understanding of how economic growth is influenced by various factors in North Africa. The results underscore the importance of promoting policies that enhance export performance and manage environmental impacts, while also considering the nuanced effects of domestic investment and imports. This approach could help North African countries navigate the challenges of economic development while achieving more balanced and sustainable growth outcomes.

5.1.Recommendations

Based on the findings of this study, several policy recommendations emerge to enhance economic growth in North African countries. First, the negative impact of domestic investment on economic growth suggests a need for more effective deployment of investment resources. Policymakers should focus on improving the efficiency and productivity of domestic

investments by prioritizing sectors with high growth potential and fostering an environment conducive to innovation and technological advancement. This might involve reforms to enhance the investment climate, such as reducing bureaucratic hurdles, improving infrastructure, and providing incentives for private sector investment in high-value areas.

Second, the positive association between CO2 emissions and economic growth highlights the need for a dual approach: promoting economic growth while addressing environmental sustainability. Policymakers should implement green technologies and energy-efficient practices that mitigate CO2 emissions without stifling economic progress. This can include investing in renewable energy sources, adopting cleaner production processes, and supporting policies that encourage businesses to reduce their carbon footprint. By aligning environmental goals with economic strategies, North African countries can achieve sustainable growth that balances economic benefits with ecological responsibility.

Third, the significant positive effect of exports on economic growth underscores the importance of trade openness. To capitalize on this, North African countries should implement policies that enhance their export capabilities. This includes improving trade logistics, reducing trade barriers, and negotiating favorable trade agreements. Additionally, supporting local industries to increase their competitiveness in international markets can help diversify export products and expand market reach. Investing in skills development and technological upgrades can also enhance the quality and competitiveness of export goods.

Conversely, while the negative effect of imports was found to be statistically insignificant, it is still prudent to monitor and manage import levels to ensure that they do not adversely impact local industries. This can involve reviewing trade policies to balance imports and exports, supporting domestic industries to improve their competitive edge, and implementing measures to prevent trade imbalances that could destabilize the economy.

5.2.Limitations

Despite the valuable insights provided by this study, there are several limitations that should be acknowledged. First, the static gravity model used in the analysis, while effective for understanding broad trends, may not fully capture the dynamic nature of economic growth and its determinants. The model's reliance on panel data from 1998 to 2022 may obscure short-term fluctuations and structural changes within the economies of North African countries. Future research could benefit from incorporating dynamic models that account for temporal variations

and structural shifts. Second, the study's focus on CO2 emissions as a proxy for environmental impact may not encompass the full range of environmental factors affecting economic growth. Other environmental indicators, such as air quality or resource depletion, could also play significant roles. A more comprehensive approach to environmental sustainability, including a broader set of environmental indicators, might provide a fuller picture of the trade-offs between economic growth and environmental protection.

Third, while the study provides a broad overview of the impact of domestic investment, labor, CO2 emissions, exports, and imports, it does not delve into the specific mechanisms through which these variables influence economic growth. Future research could explore the underlying channels and processes that mediate these relationships, offering deeper insights into how these factors interact within the North African economic context.

5.3.Future Research Directions

Future research could extend this study in several meaningful ways. One potential avenue is to explore the effects of additional economic variables and structural factors on growth. For instance, incorporating elements such as financial sector development, institutional quality, and governance could provide a more nuanced understanding of the determinants of economic growth in North Africa.

Another important area for future research is the application of dynamic models to capture the temporal dimensions of economic growth and its drivers. Dynamic panel data models or time-series analyses could help identify short-term and long-term effects, as well as potential structural breaks or shifts in the relationships between the variables.

Additionally, research could investigate the impact of sector-specific investments and policies on economic growth. Examining how investments in different sectors, such as technology, education, or infrastructure, affect growth outcomes could offer more targeted policy recommendations.

Lastly, expanding the geographic scope of the study to include other regions with similar economic contexts could provide comparative insights and enhance the generalizability of the findings. Comparative analyses between North African countries and other developing regions could reveal common patterns and divergences in how economic growth is influenced by investment, trade, and environmental factors.

While this study provides valuable insights into the interplay between CO2 emissions, domestic investment, and trade openness in North Africa, addressing its limitations and pursuing further research can offer more comprehensive and actionable knowledge for policymakers and researchers alike. By continuing to refine and expand the analytical frameworks used to study economic growth, we can better understand and address the complex challenges facing North African economies and contribute to their sustainable development.

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