Impacts of Agricultural Exports and CO2 Emissions on Economic Growth: New Evidence from High Income Countries

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Abstract:

This study examines the impact of agricultural exports and CO2 emissions on economic growth in 78 high-income countries from 2004 to 2023. Using a robust econometric framework that includes fixed-effects and random-effects models, the research finds that agricultural exports positively influence economic growth by generating revenue and enhancing competitiveness, while CO2 emissions negatively affect growth due to the associated environmental costs. The analysis, supported by the Hausman test and panel data techniques, highlights the need for balanced policy interventions that promote agricultural export growth while mitigating CO2 emissions. This study provides valuable insights for policymakers seeking to achieve sustainable economic development by integrating environmental considerations into economic strategies.

Keywords: Agricultural Exports, CO2 Emissions, Economic Growth, Static Gravity Model, High-Income-Countries.

JEL classification : F11, F14, O47, Q17, Q18, R11.

1. Introduction

The investigation into the impacts of agricultural exports and CO2 emissions on economic growth is a subject of profound importance, resonating with the core challenges and opportunities that define the current global economic and environmental landscape. In an era where economic development is inextricably linked with environmental sustainability, understanding the interplay between these variables is essential for crafting policies that not only foster growth but also ensure the long-term health of our planet. Agricultural exports have historically played a crucial role in the economic development of nations, particularly those with significant agricultural sectors. These exports contribute to foreign exchange earnings, support rural development, and create employment opportunities, thereby acting as a catalyst for economic growth (World Bank, 2019). However, the environmental impact of agricultural activities, particularly in terms of CO2 emissions, has raised significant concerns. Agriculture is a major source of greenhouse gas emissions, contributing to global warming and climate change, which in turn have far-reaching implications for economic stability and growth (IPCC, 2021). The dual focus on agricultural exports and CO2 emissions, therefore, captures the delicate balance that must be struck between economic prosperity and environmental stewardship.

When examining this subject within the context of high-income countries, the relevance and importance become even more pronounced. High-income countries, which are characterized by advanced industrial economies, robust financial systems, and high levels of human development, are often at the forefront of global economic activities, including trade and agriculture (OECD, 2020). These countries have the technological capabilities and resources to implement sustainable agricultural practices, yet they are also significant contributors to global CO2 emissions. The agricultural sectors in these nations, while more efficient and technologically advanced, still face challenges related to environmental sustainability. High-income countries often export a substantial portion of their agricultural produce, making agricultural exports a key component of their trade balance and economic health (FAO, 2020). However, the intensification of agricultural practices to meet global demand can lead to increased CO2 emissions, exacerbating climate change and potentially undermining the very economic growth that these exports are intended to support (UNFCCC, 2019). The exploration of this topic within the realm of high-income countries is thus critical for understanding how these nations can reconcile the competing demands of economic growth and environmental protection.

The decision to focus on this subject is driven by several compelling factors. First, high-income countries serve as global leaders in both economic and environmental policy, making them ideal case studies for examining the complex relationship between agricultural exports, CO2 emissions, and economic growth. These countries have the resources to invest in cutting-edge technologies and practices that can reduce the environmental impact of agriculture while maintaining or even enhancing productivity (World Bank, 2021). Studying the experiences of high-income countries can provide valuable insights into the effectiveness of various policy measures and technological innovations aimed at achieving sustainable growth. Furthermore, high-income countries often set trends in global trade and environmental standards, influencing practices and policies in other parts of the world. By focusing on these countries, this research can contribute to a broader understanding of how global economic and environmental goals can be aligned. The choice of this topic is also motivated by the need to fill gaps in the existing literature. While there has been extensive research on the economic impacts of agricultural exports and the environmental consequences of CO2 emissions, few studies have integrated these perspectives within the specific context of high-income countries. This research aims to bridge this gap by providing a comprehensive analysis of how agricultural exports and CO2 emissions interact to influence economic growth in these economically advanced nations.

The value added by this research extends beyond the academic sphere, offering practical implications for policymakers, economists, and environmentalists alike. By providing empirical evidence on the relationship between agricultural exports, CO2 emissions, and economic growth in high-income countries, this study can inform the development of more effective and sustainable economic policies. The findings can help policymakers design strategies that promote economic growth through agricultural exports while minimizing the environmental impact, thereby contributing to the global effort to combat climate change (OECD, 2021). Additionally, this research can guide international organizations and agencies in their efforts to support sustainable development in high-income countries and beyond. By highlighting the challenges and opportunities associated with balancing economic growth and environmental sustainability, this study contributes to the ongoing dialogue on how to achieve the United Nations Sustainable Development Goals (UN SDGs), particularly those related to economic growth, climate action, and responsible consumption and production (UN, 2020). Moreover, this work provides a framework for future research, encouraging further exploration of the complex interactions between economic activities and environmental outcomes in different contexts and regions. In doing so, it not only enhances our understanding of these critical issues

but also supports the development of more integrated and holistic approaches to global economic and environmental governance. The examination of the impacts of agricultural exports and CO2 emissions on economic growth in high-income countries is a subject of immense importance, with far-reaching implications for both economic and environmental policy. By focusing on high-income countries, this research addresses a critical gap in the literature and provides valuable insights into how these nations can achieve sustainable growth. The findings of this study will contribute to the broader discourse on global sustainability, offering practical guidance for policymakers and serving as a foundation for future research. Through this work, we hope to advance the understanding of how economic and environmental objectives can be harmonized, ultimately supporting the global effort to create a more sustainable and prosperous future.

To provide a comprehensive analysis of the impacts of agricultural exports and CO2 emissions on economic growth, this study is organized into several key sections, each building upon the previous one to create a coherent narrative. The second section focuses on a detailed literature review, which examines the existing research on the relationship between CO2 emissions and economic growth, as well as the relationship between agricultural exports and economic growth. This section places particular emphasis on understanding the link between exports and economic growth, as well as the connection between agriculture and economic growth. By synthesizing the findings from various studies, this literature review sets the foundation for understanding the theoretical and empirical frameworks that have been developed in this field, highlighting the gaps that this study aims to address.

Following the literature review, the third section presents our empirical methodology. This section details the variables chosen for the analysis, ensuring that they accurately reflect the factors influencing economic growth, agricultural exports, and CO2 emissions. It also discusses the period of estimation, which is determined based on the availability of data, ensuring that the analysis is both comprehensive and relevant. The methodology section further outlines the model selected for the study, providing a rationale for its choice and discussing how it will be applied to investigate the research questions. Additionally, this section elaborates on the empirical strategy that will be employed, including the econometric techniques and tests that will be used to ensure the robustness and reliability of the results.

The fourth section is dedicated to presenting our empirical results. This section provides a detailed analysis of the data, interpreting the findings in the context of the existing literature

and the hypotheses set forth in the earlier sections. The results are presented in a clear and systematic manner, with a focus on how they contribute to our understanding of the relationship between agricultural exports, CO2 emissions, and economic growth in high-income countries. Any unexpected findings are also discussed, along with their potential implications for theory and policy. Finally, the fifth section offers conclusions and recommendations. Based on the empirical findings, this section summarizes the key insights of the study, highlighting the implications for policymakers, economists, and other stakeholders. Recommendations are provided on how high-income countries can balance economic growth with environmental sustainability, particularly in the context of agricultural exports and CO2 emissions. This final section also suggests areas for future research, encouraging further exploration of the complex dynamics between economic activities and environmental outcomes.

2. Literature Survey

The second section of this study delves deeply into a comprehensive literature review, where the primary aim is to explore the extensive body of research that has been conducted on two crucial relationships: the relationship between CO2 emissions and economic growth, and the relationship between agricultural exports and economic growth. This literature review is not just a cursory overview; rather, it is an in-depth analysis that seeks to uncover the intricate dynamics and nuances that characterize these relationships.

2.1.CO2 emissions and economic growth

To begin with, the review examines the vast array of studies that have focused on how CO2 emissions, as a byproduct of industrial and agricultural activities, impact economic growth. This part of the review is critical because it helps to understand the broader context in which economic development occurs, especially in light of the environmental challenges posed by greenhouse gas emissions. By analyzing various theoretical models and empirical studies, this section aims to provide a clear picture of how CO2 emissions have been linked to both the acceleration and hindrance of economic growth, depending on the context and the specificities of different countries and regions.

The relationship between CO2 emissions and economic growth has been a central topic of academic inquiry for several decades, reflecting the broader concerns about the environmental impacts of sustained economic development. This relationship is complex, dynamic, and multifaceted, and has been explored through various theoretical frameworks and empirical

studies, leading to diverse and sometimes conflicting conclusions. The following literature review delves into the core debates and findings that have emerged in this field, tracing the evolution of thought on how economic growth influences CO2 emissions and vice versa.

One of the foundational theories in this area is the Environmental Kuznets Curve (EKC) hypothesis, which posits that there is an inverted U-shaped relationship between environmental degradation, including CO2 emissions, and economic growth. According to this hypothesis, as an economy grows and industrializes, environmental degradation initially worsens, leading to higher levels of pollution and resource depletion. However, as income per capita reaches a certain threshold, the trend reverses, and further economic growth leads to improvements in environmental quality. This turning point is attributed to several factors, including technological advancements, structural changes in the economy, and increased demand for environmental regulation as societies become wealthier. Grossman and Krueger (1991) were among the first to empirically test the EKC hypothesis, finding evidence that supports the notion of a turning point where economic growth begins to correlate with environmental improvements.

However, the EKC hypothesis has not gone unchallenged. Critics argue that the empirical evidence supporting the EKC is mixed and often context dependent. For instance, while some high-income countries may exhibit the inverted U-shaped relationship, this may not hold true for developing economies where economic growth remains heavily reliant on carbon-intensive industries. Furthermore, the observed reduction in CO2 emissions in some advanced economies may be the result of outsourcing pollution-intensive production to developing countries rather than genuine improvements in environmental management. This phenomenon, often referred to as the "pollution haven hypothesis," suggests that stringent environmental regulations in developed countries may lead to the relocation of dirty industries to countries with lax environmental standards, thereby displacing rather than reducing global CO2 emissions (Copeland and Taylor, 2004).

The relationship between CO2 emissions and economic growth also varies significantly across different regions and countries, influenced by factors such as energy consumption patterns, industrial structure, and environmental policies. In many developing countries, economic growth continues to drive higher CO2 emissions, as these economies rely on fossil fuels to power their industrialization and urbanization processes. Studies by Ang (2007) and Apergis and Payne (2009) highlight the persistent link between economic growth and CO2 emissions in these contexts, where energy consumption is a key driver of both economic expansion and

environmental degradation. These findings suggest that without a transition to cleaner energy sources, economic growth in developing countries may exacerbate global CO2 emissions.

Energy consumption is indeed a critical intermediary in the relationship between economic growth and CO2 emissions. The type of energy consumed, the efficiency of energy use, and the availability of renewable energy sources all play significant roles in determining the environmental impact of economic activities. Shahbaz et al. (2013) and Sadorsky (2014) have emphasized the importance of energy efficiency improvements and the adoption of renewable energy technologies in mitigating the environmental impact of economic growth. Their research indicates that while economic growth can lead to increased CO2 emissions through higher energy consumption, this effect can be counterbalanced by shifts in the energy mix towards cleaner sources and improvements in energy efficiency.

The direction of causality between CO2 emissions and economic growth has also been a subject of extensive research, with varying results across different studies. Some researchers, such as Soytas and Sari (2007) and Ozturk and Acaravci (2010), have found evidence of unidirectional causality running from economic growth to CO2 emissions. This suggests that economic growth drives increase in CO2 emissions, but not necessarily the other way around. In such cases, policies aimed at reducing CO2 emissions may not significantly impede economic growth, as the two are not causally linked in a bidirectional manner. However, other studies have identified bidirectional causality, indicating a feedback loop where economic growth and CO2 emissions mutually influence each other. This bidirectional relationship implies that CO2 emissions can constrain economic growth, particularly if environmental degradation reaches levels that harm public health, reduce labor productivity, or necessitate costly mitigation measures (Stern, 2006).

The impact of CO2 emissions on long-term economic growth is another area of concern. High levels of CO2 emissions contribute to climate change, which poses significant risks to economic stability and growth. Climate-related events such as extreme weather, sea-level rise, and changing precipitation patterns can disrupt economic activities, damage infrastructure, and lead to loss of life and property. These impacts are particularly severe for developing countries, which are often more vulnerable to climate change due to their geographic location, economic dependence on climate-sensitive sectors, and limited capacity to adapt (IPCC, 2014). Therefore, unchecked CO2 emissions may lead to negative economic outcomes in the long run, even if they initially accompany economic growth.

In response to these challenges, the concept of 'green growth' has gained traction in recent years. Green growth advocates argue that it is possible to achieve economic growth while simultaneously reducing CO2 emissions, through the adoption of sustainable development practices, the promotion of clean energy technologies, and the implementation of effective environmental policies. The transition to a low-carbon economy, as discussed by Bowen and Hepburn (2014), requires significant investment in renewable energy, energy efficiency, and low-carbon infrastructure. These investments can drive economic growth by creating new industries, generating employment, and improving energy security. Moreover, policies such as carbon pricing, emissions trading systems, and subsidies for clean energy can incentivize the reduction of CO2 emissions while maintaining economic competitiveness.

However, the transition to green growth is not without challenges. The economic costs of shifting away from fossil fuels can be significant, particularly for countries that are heavily dependent on carbon-intensive industries. Additionally, the distribution of costs and benefits associated with green growth policies may be uneven, both within and between countries. Developing countries, in particular, may face difficulties in financing the transition to a low-carbon economy, especially if they lack access to technology and financial resources. International cooperation and financial support are therefore crucial to ensuring that the global transition to green growth is both effective and equitable (UNEP, 2011).

Bakari (2022a) investigates the impact of CO2 emissions on economic growth across 52 African countries from 1996 to 2021. The study finds that CO2 emissions do not have a statistically significant effect on economic growth in these countries. This suggests that, for the period studied, carbon emissions were not a critical factor influencing economic expansion in Africa. This finding contrasts with the conventional belief that environmental degradation invariably hampers economic performance. However, Bakari et al. (2021a) provide a different perspective in their study focused on Tunisia, where they observe a negative, though insignificant, impact of pollution on economic growth between 1971 and 2015. This insignificance suggests that while pollution may not have had a direct detrimental effect on economic growth during this period, it holds potential future risks if left unmanaged.

In a more recent study, Bakari (2024a) shifts the focus to Sub-Saharan Africa, examining the impact of CO2 emissions alongside domestic investments on economic growth from 1990 to 2022. Contrary to earlier findings, this study reveals that CO2 emissions positively and significantly influence economic growth in the region. The positive relationship underscores

the complex dynamics in developing economies, where the economic activities leading to emissions also drive growth. However, the study emphasizes the importance of sustainable management of these emissions to avoid long-term adverse effects.

Other studies explore the relationship in different contexts and regions. Radmehr et al. (2021) analyze the nexus among renewable energy consumption, CO2 emissions, and economic growth in EU countries, revealing a bidirectional relationship between economic growth and carbon emissions. This indicates that in developed economies, where energy consumption and environmental awareness are high, economic growth and emissions influence each other, reflecting the intricate balance between development and sustainability. In East Asia, Saboori et al. (2017) explore the relationship between oil consumption, CO2 emissions, and economic growth in China, Japan, and South Korea. The study finds a long-run relationship between these variables, with uni-directional causality from oil consumption to economic growth and from oil consumption to CO2 emissions in South Korea. This highlights the dependency of these economies on carbon-intensive energy sources for growth, which poses significant environmental challenges.

The impact of CO2 emissions on economic growth is further examined by Espoir et al. (2022) in Africa, where the authors reveal that a 1% increase in CO2 emissions spurs income by 0.23%. This result suggests that emissions, despite their environmental costs, contribute positively to economic production in the continent. However, the study also highlights the heterogeneous effects across different climate regimes within Africa, stressing the need for tailored environmental policies that account for regional specificities. Sun et al. (2020) examined the non-linear nexus between CO2 emissions and economic growth, comparing OECD and Belt and Road (B&R) countries from 1992 to 2015. Their study confirmed the EKC hypothesis across all panels, indicating that economic growth initially increases environmental pollution before leading to improvements. The study employed advanced econometric techniques like the Common Correlated Effect Mean Group (CCEMG) and Augmented Mean Group (AMG) methods, revealing that growth output significantly impacts environmental pollution. The results also demonstrated that factors like trade openness, urbanization, and energy usage have contributed to the global rise in carbon emissions, with a more pronounced effect in OECD countries. Hubacek et al. (2021) provided evidence of decoupling between consumption-based CO2 emissions and economic growth, emphasizing the importance of a consumption-based perspective. Their analysis showed that 32 out of 116 countries achieved absolute decoupling between GDP and production-based emissions, while 23 countries decoupled GDP from

consumption-based emissions between 2015 and 2018. The study highlighted the challenges of maintaining decoupling and the necessity of decarbonizing supply chains for sustained environmental benefits.

Ahmad and Du (2017) focused on Iran, exploring the long-term relationship between energy production, CO2 emissions, and economic growth from 1971 to 2011. Their findings supported a positive relationship between CO2 emissions and economic growth, with domestic investment playing a more significant role than foreign investment in driving economic growth. The study used the ARDL approach, confirming the robustness of their results through various diagnostic tests and econometric models. Wang et al. (2011) analyzed the causal relationships between CO2 emissions, energy consumption, and economic growth in China from 1995 to 2007. The study found a bidirectional causality between CO2 emissions and energy consumption, as well as between energy consumption and economic growth. Their results indicated that China's CO2 emissions would likely continue to rise, suggesting potential conflicts between emission reduction efforts and economic growth. Ahmad et al. (2017) investigated the EKC hypothesis in Croatia, using data from 1992Q1 to 2011Q1. The study confirmed the inverted U-shaped relationship between CO2 emissions and economic growth, supporting the EKC hypothesis in the long run. The findings also demonstrated bidirectional causality between CO2 emissions and economic growth in the short run, with a unidirectional causality from economic growth to CO2 emissions in the long run. Narayan et al. (2016) expanded the analysis to 181 countries, exploring the dynamic relationship between economic growth and CO2 emissions. Their innovative approach using cross-correlation estimates provided evidence supporting the EKC hypothesis in 12% of the countries studied. The research also found that in 27% of the countries, income growth would likely reduce future emissions, highlighting the potential for sustainable growth.

De Freitas and Kaneko (2011) examined the decoupling of economic growth and CO2 emissions in Brazil from 2004 to 2009, identifying periods of relative decoupling. The study used a decomposition model based on the log-mean Divisia index (LMDI) framework, finding that carbon intensity and energy mix were key determinants of emission reductions during the period studied. Muhammad (2019) explored the relationship between economic growth, energy consumption, and CO2 emissions in 68 countries, including developed, emerging, and MENA countries, from 2001 to 2017. The study found that while energy consumption increased economic growth in developed and emerging countries, it had a negative impact in MENA countries. The results suggested the need for environmentally friendly technologies to reduce

CO2 emissions without hindering economic growth. Lee and Brahmasrene (2014) focused on ASEAN countries, examining the long-run and short-run relationships among ICT, CO2 emissions, and economic growth from 1991 to 2009. The study found significant positive effects of ICT on both economic growth and CO2 emissions, with bidirectional relationships between economic growth and CO2 emissions in the region.

Ozturk and Acaravci (2010) analyzed the long-run and causal relationships between economic growth, carbon emissions, energy consumption, and employment ratio in Turkey from 1968 to 2005. Their results suggested that energy conservation policies could be implemented without adversely affecting economic growth, as neither carbon emissions nor energy consumption were found to cause real GDP per capita. Azam et al. (2016) investigated the impact of CO2 emissions on economic growth in high CO2 emission economies, including China, the USA, India, and Japan, from 1971 to 2013. Their findings revealed that CO2 emissions had a significant positive relationship with economic growth in China, Japan, and the USA, but a negative relationship in India. The study emphasized the need for policies that address pollution from sources other than liquefied fuel consumption.

Acheampong (2018) used a panel vector autoregression (PVAR) and System-GMM approach to examine the dynamic causal relationship between economic growth, carbon emissions, and energy consumption for 116 countries from 1990 to 2014. The study found that economic growth did not cause energy consumption at the global and regional levels, but carbon emissions positively influenced economic growth, particularly in sub-Saharan Africa. Mardani et al. (2019) offer a comprehensive review of the relationship between carbon dioxide (CO2) emissions and economic growth, focusing on studies published between 1995 and 2017. The authors highlight that understanding this nexus is crucial for formulating energy policies that promote sustainable economic growth. Despite numerous studies on the topic, the authors identify a gap in the literature regarding qualitative systematic reviews and meta-analyses. The study employs a qualitative systematic and meta-analysis method, specifically the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach, to review 175 articles from 55 international journals. The review categorizes the articles by various criteria, including the author's name, year of publication, data duration, analytical techniques, indicators used, country focus, and results. This detailed categorization allows for a broad understanding of the relationship between CO2 emissions and economic growth. The findings indicate that the relationship between CO2 emissions and economic growth is bidirectional, meaning that changes in economic growth can lead to changes in CO2 emissions and vice versa.

This bidirectional causality suggests that efforts to reduce CO2 emissions could potentially hinder economic growth, presenting a significant challenge for policymakers. The study underscores the importance of carefully considering these dynamics when developing policies aimed at reducing emissions while promoting economic growth.

The relationship between CO2 emissions and economic growth is a complex and evolving area of study, with important implications for both economic policy and environmental sustainability. While the EKC hypothesis offers one perspective on how economic growth and environmental quality may be reconciled, the empirical evidence is mixed and context dependent. The persistent link between economic growth and CO2 emissions in many developing countries highlights the challenges of achieving sustainable development in a carbon-constrained world. Moreover, the direction of causality between CO2 emissions and economic growth remains a contested issue, with implications for how policymakers approach the twin goals of economic development and environmental protection. As the global community continues to grapple with the challenges of climate change, the pursuit of green growth offers a potential pathway for reconciling economic and environmental objectives. However, achieving this vision will require concerted efforts in policymaking, technological innovation, and international cooperation.

2.2. Agricultural exports and economic growth

Simultaneously, the literature review explores the relationship between agricultural exports and economic growth, a topic of significant importance, particularly for countries with substantial agricultural sectors. This exploration includes a detailed examination of how agricultural exports contribute to economic development through various channels such as foreign exchange earnings, job creation, and rural development. By comparing and contrasting findings from different studies, this section seeks to identify the key factors that influence the strength and direction of the relationship between agricultural exports and economic growth.

Importantly, this literature review places particular emphasis on understanding the link between exports and economic growth, as well as the connection between agriculture and economic growth. These links are explored in great detail, as they form the core of the research question that this study seeks to address. By synthesizing the findings from various studies, the review not only provides a summary of existing knowledge but also critically evaluates the methodologies and conclusions of previous research. This critical evaluation is essential for

identifying any gaps or inconsistencies in the literature, which in turn highlight the areas where further research is needed.

Numerous scholars and studies have established that agricultural investments and the broader agricultural sector play a pivotal role in fostering economic growth and stimulating economic activity. The evidence supporting this assertion is vast, with a range of academic works underscoring the favorable impact of agriculture on economic development. For instance, Sertoglu et al. (2017) and Michael (2017) provide empirical analyses that highlight the positive correlation between agricultural investments and economic expansion. Similarly, Gollin (2010) explores how the agricultural sector serves as a critical driver of economic growth, particularly in developing economies. Olabanji et al. (2017) and Ismail and Kabuga (2016) further emphasize the importance of agriculture in driving macroeconomic stability and growth. Brückner (2012) and Akanbi et al. (2019) delve into the mechanisms through which agricultural productivity contributes to broader economic performance, while Chandio et al. (2019) and Izuchukwu (2011) illustrate the sector's role in enhancing economic resilience. Additional studies by Chandio et al. (2016), Bashir and Susetyo (2018), and Epaphra and Mwakalasya (2017) reinforce these findings, demonstrating the significant economic benefits derived from sustained agricultural investment. Research by Xuezhen et al. (2010), Awunyo-Vitor and Sackey (2018), Şimşir (2012), and Oyakhilomen and Zibah (2014) further corroborates the critical role of agriculture in economic development, with particular attention to the sector's impact on employment and income generation. Similarly, Ciglovska (2018), Seok and Moon (2021), and Self and Grabowski (2007) provide robust evidence linking agricultural investments to improved economic outcomes. Studies by Subramaniam and Reed (2009), Abdelhafidh and Bakari (2019), and Bakari (2018a) extend this analysis, highlighting the sector's strategic importance in both developed and developing contexts. Further contributions by Bakari et al. (2021b), Bakari and Tiba (2020), and Bakari and El Weriemmi (2022) underscore the enduring significance of agriculture in driving economic progress, while Bakari and Abdelhafidh (2018), Bakari and Brahmi (2020), Bakari and Weriemmi (2024), Bakari et al. (2020), and Bakari (2020) provide a comprehensive examination of the sector's role in economic development.

Similarly, other research underscores the agricultural sector's crucial contribution to achieving sustainable development goals. For instance, Anwer et al. (2015) and McArthur and McCord (2017) emphasize the sector's role in promoting sustainable economic growth, while Chandio et al. (2019) and Verter and Bečvářová (2016) highlight its importance in ensuring food security

and reducing poverty. Ugwu and Kanu (2012), Kulshrestha and Agrawal (2019), and Hye and Jafri (2011) explore the sector's potential to drive inclusive growth and environmental sustainability. Additionally, Meijerink and Roza (2007), Onunwo and Amadi-Robert (2022), and Shah et al. (2015) examine how agricultural practices can be aligned with sustainable development objectives. Research by Mkhatshwa et al. (2015), Gilbert et al. (2013), and Yazdani (2008) further highlights the sector's role in fostering resilience and adaptability to climate change, while Simasiku and Sheefeni (2017) and Edeh et al. (2020) provide insights into how agricultural investments contribute to sustainable livelihoods. Studies by Oloyede (2014), Paramati et al. (2018), and Foster and Rosenzweig (2004) emphasize the sector's capacity to generate economic growth while addressing environmental challenges. Additional contributions by Cao and Birchenall (2013), Alexander (2013), and Pacheco et al. (2018) underscore the importance of integrating sustainable practices into agricultural production. Iddrisu et al. (2015), Arifah and Kim (2022), Awan and Mustafa (2013), and Lanz et al. (2018) further explore the sector's potential to support sustainable development through innovation and policy interventions.

In line with these findings, numerous studies have also demonstrated the importance of exports in contributing to economic growth. For example, Bakari (2024b), Bakari (2022b), and Bakari and Tiba (2022a) provide comprehensive analyses of the role of exports in driving economic expansion. Research by Bakari et al. (2019), Bakari (2021), and Bakari (2017a) underscores the significance of export-led growth strategies in enhancing economic performance. Bakari and Tiba (2019), Bakari (2016a), and Bakari et al. (2022) further highlight the positive impact of exports on economic development, particularly in emerging markets. Additional studies by Bakari (2017b), Bakari and Krit (2017), and Bakari and Mabrouki (2017a) provide empirical evidence supporting the export-growth nexus, while Ahmad et al. (2017) and Ram (1985) offer historical perspectives on the role of exports in economic development. Research by Mishra (2011), Jetter (2017), and Usman et al. (2012) further explores the link between exports and economic growth, with particular attention to the mechanisms through which exports contribute to economic stability and diversification. Studies by Hameed et al. (2012), Ullah et al. (2009), and Nguyen (2020) provide additional insights into the export-growth relationship, emphasizing the importance of export diversification and value addition. Hashim (2016), Hamdan (2016), and Reddy (2020) further reinforce the role of exports in driving economic progress, while Abdulla and Ali (2019), Osabohien et al. (2019), and Mehrara and Baghbanpour (2016) highlight the strategic importance of exports in fostering economic resilience. Finally,

research by Ugochukwu and Chinyere (2013), Ismail et al. (2009), Sultanuzzaman et al. (2019), Mahmoodi and Mahmoodi (2016), Abbas (2012), Ahmad (2001), Mehta (2015), Rangasamy (2009), Nguyen (2011), Hassouneh (2019), Shahbaz and Mafizur-Rahman (2014), Ahmad et al. (2018), and Rinta and Suhartono (2022) provides a comprehensive overview of the various dimensions through which exports contribute to economic growth, offering valuable insights for policymakers and researchers alike.

The relationship between agricultural exports and economic growth is a pivotal subject in economic development studies. Agricultural exports are often viewed as a fundamental component in the economic advancement of many countries, particularly those where agriculture forms a substantial part of the economy. This literature review explores the intricate dynamics between agricultural exports and economic growth, emphasizing various mechanisms, empirical evidence, and theoretical perspectives. By delving into different facets of this relationship, we can better understand how agricultural exports contribute to economic progress and the challenges involved. Agricultural exports have long been linked to economic growth through several theoretical frameworks. Classical economic theories, such as David Ricardo's Theory of Comparative Advantage, posit that countries should specialize in the production of goods for which they have a relative efficiency advantage. For agricultural economies, this means focusing on crops and livestock that can be produced efficiently and traded internationally (Ricardo, 1817). According to this theory, agricultural exports allow countries to benefit from trade by exchanging surplus agricultural products for goods that are more costly to produce domestically, thereby enhancing overall economic welfare.

Further development in trade theory, particularly the Heckscher-Ohlin Model, adds another layer to our understanding. This model suggests that countries export goods that utilize their abundant factors of production and import goods that require factors in which they are scarce (Heckscher and Ohlin, 1991). For developing countries rich in land and labor but lacking capital, agricultural products are often their primary export goods. By engaging in international trade, these countries can achieve economic growth through efficient resource utilization and increased production capacities. In the context of modern growth theories, the Endogenous Growth Theory offers a more nuanced perspective. This theory emphasizes the role of technological innovation and human capital in driving economic growth. For agricultural sectors, technological advancements in crop management, pest control, and farm mechanization can lead to increased productivity and higher export volumes (Romer, 1990). The adoption of such technologies often translates into improved economic performance, as countries are able

to produce higher quality goods and expand their market reach. Empirical studies have consistently highlighted the positive correlation between agricultural exports and economic growth, although the extent and nature of this relationship can vary based on regional contexts and economic conditions. In Sub-Saharan Africa, where agriculture remains a primary economic activity, agricultural exports are often a critical driver of economic development. For instance, Dethier and Effenberger (2012) found that countries in this region with robust agricultural export sectors tend to experience faster economic growth. Their research underscores how agricultural exports contribute to national income through foreign exchange earnings and investment in other sectors of the economy. In contrast, agricultural export growth does not always translate seamlessly into economic progress. Minot and Daniels (2005) argue that while agricultural exports can boost national income, they are also susceptible to price volatility, which can undermine economic stability. Their study highlights that fluctuations in global agricultural prices can affect the income of farmers and disrupt economic growth, emphasizing the need for effective risk management strategies. Latin American countries present another important case for understanding the link between agricultural exports and economic growth. Research by Timmer (1998) on countries like Brazil and Argentina demonstrates how agricultural exports have driven economic development by improving trade balances and stimulating industrial growth. Brazil's success in exporting soybeans and Argentina's beef exports illustrate how countries with competitive agricultural sectors can achieve significant economic benefits. These case studies reflect the broader trend where agricultural exports contribute to economic growth through enhanced trade balances and increased foreign exchange earnings.

In Asia, the impact of agricultural exports on economic growth has been particularly evident in countries like China and India. The growth of agricultural exports in these countries has been accompanied by substantial economic progress. For example, studies by Zhang and Fan (2004) show that China's agricultural export sector has significantly contributed to the country's rapid economic growth. The export of agricultural products has supported China's trade surpluses and facilitated investment in infrastructure and technology, further fueling economic development. Similarly, India's agricultural exports, particularly in commodities such as rice and spices, have played a crucial role in its economic growth trajectory (Kumar et al., 2011).

Solanki et al (2022) investigated the dynamic linkage between agricultural exports and the financial performance of agricultural firms in India from 2012 to 2019, utilizing the system generalized method of moments (GMM). The study revealed a significant negative correlation

between agricultural exports and interest rates, suggesting that higher interest rates and increased value addition to GDP could reduce agricultural exports. Interestingly, the findings indicate that an increase in agricultural exports might reduce profit margins for firms, suggesting that agricultural exports do not always directly enhance economic growth but can have complex effects on sectoral performance. Arifah and Kim (2022) examined the impact of the COVID-19 pandemic on agricultural exports and their contribution to economic growth in Indonesia. Using a 2SLS regression model, they found that agricultural exports positively affected economic growth during the pandemic, with a 1% increase in agricultural exports potentially raising economic growth by 0.69%. This study underscores the resilience of the agricultural sector during economic crises and suggests that strategic export policies can enhance growth even in challenging times. Jaunky (2011) explored the causal relationship between fish exports and economic growth in 23 Small Island Developing States (SIDS) from 1989 to 2002. The study employed various panel econometric techniques, including the Blundell-Bond system GMM method, to establish a bidirectional causality between fish exports and economic growth. The findings highlighted that fish exports could sustain economic growth in SIDS, emphasizing the need for effective management of fisheries to maintain this growth trajectory.

Kappa (2022) analyzed the impact of vegetable exports on economic growth in selected SAARC economies over the period 1988–2018. The study employed panel econometric techniques and concluded that vegetable exports do not significantly lead to economic growth in these economies, rejecting the export-led growth hypothesis. Nonetheless, a long-term relationship between vegetable exports, imports, capital, and economic growth was identified, indicating that while vegetable exports alone may not drive growth, they contribute to a broader economic framework that supports growth. Gizaw et al (2022) focused on the role of coffee exports in Ethiopia's economic growth from 1980 to 2017. Their study employed a vector error correction model (VECM) and revealed that coffee exports have a significant positive impact on long-term economic growth. Additionally, the study found a bidirectional causality between coffee exports and economic growth, suggesting that enhancing coffee export efficiency could be vital for sustaining Ethiopia's economic growth. Batool and Sheikh (2024) examined the role of food security and agricultural exports in shaping economic growth trajectories in 89 developing countries from 1990 to 2020. Using Method of Moments Quantile Regression (MMQR), the study found that adequate food availability positively impacts economic growth by promoting health and productivity. The findings suggest that agricultural exports, alongside

improved food security, can significantly influence growth in developing countries, although income inequality and food stability also play crucial roles. El Weriemmi and Bakari (2024) investigated the effect of agricultural exports on economic growth in 12 low-income countries from 2004 to 2023 using an advanced gravity model. The study found that agricultural exports positively contribute to economic development when various controls, such as capital, labor, and other exports, are accounted for. The results emphasize the importance of targeted agricultural export policies in fostering economic growth in low-income countries.

Bakari and Tiba (2022b) analyzed the impact of agricultural exports on economic growth in China from 1984 to 2017. The study employed the ARDL bounds testing approach and found that agricultural exports have a positive effect on long-term economic growth. Interestingly, agricultural imports were found to have a negative impact on growth, highlighting the complex interplay between exports and imports in China's agricultural sector. Bakari's series of studies (2016b, 2017c,d, 2018b) on Tunisia provide a detailed examination of how different types of agricultural exports, including citrus, olive oil, and vegetables, influence economic growth. His findings consistently show that agricultural exports positively impact economic growth in both the short and long term, although the extent of this impact varies across different agricultural products. These results highlight the need for robust strategies to enhance the contribution of agricultural exports to Tunisia's economic growth. Bakari and Mabrouki (2017b) extended this analysis to South-Eastern Europe, demonstrating that agricultural exports have a strong positive correlation with GDP and significantly contribute to economic growth. This study underscores the critical role of agricultural exports in supporting economic development in this region and the importance of refining agricultural trade policies to maximize growth benefits.

The study by Bakari and Mabrouki (2018) contributes to the understanding of the impact of agricultural trade on economic growth in North African countries. This research fills a gap in the literature by focusing on a region where the influence of agricultural exports and imports on economic growth had not been previously explored in depth. The authors collected annual data spanning from 1982 to 2016 and employed correlation analysis alongside a static gravity model to analyze the data. Their empirical findings reveal that agricultural trade, as a whole, positively correlates with the gross domestic product (GDP) of North African countries. However, a more nuanced picture emerges when disaggregating the components of agricultural trade. Specifically, the study finds that while there is a positive correlation between agricultural exports and GDP, the strength of this correlation is relatively weak. This suggests that, although agricultural exports contribute to economic growth, their influence may be limited or moderated

by other economic factors. On the other hand, agricultural imports do not appear to have any significant effect on economic growth in the region. The estimation results from the static gravity model reinforce the importance of agricultural exports as a driver of economic growth in North Africa. This finding underscores the potential of agricultural exports to act as a catalyst for economic development, despite the weak correlation observed in the initial analysis. Amao et al. (2021) investigated the impact of agricultural exports on Nigeria's economic growth from 1960 to 2016, employing the Generalized Method of Moments (GMM) model. Their findings highlight that while certain agricultural exports, like food and live animals, negatively influence economic growth, the overall impact of agricultural exports is mixed, suggesting the need for policies to enhance the quality and productivity of agricultural goods. Similarly, Jawaid et al. (2019) focused on Pakistan's fish exports, finding a positive long-term relationship with economic growth, albeit with fluctuating short-term effects. This underscores the complex nature of agricultural export impacts, which may vary depending on specific sectors and time frames.

In developed countries, Seok and Moon (2021) explored the export-led growth hypothesis in the agricultural sector within OECD countries. Their analysis reveals that agricultural exports positively influence agricultural growth, particularly in the European Union (EU) subset of OECD countries. This suggests that access to foreign markets is critical for sustaining agricultural growth in developed economies, especially within common markets like the EU. On the other hand, Sanjuán-López and Dawson (2010) examined the impact of agricultural exports on economic growth in developing countries using panel cointegration methods. Their study supports the export-led growth hypothesis, showing a significant long-term relationship between agricultural exports and GDP. However, the effect is more pronounced in non-agricultural exports, indicating that a balanced approach to export promotion may be more beneficial for economic growth in these regions. In Ghana, Siaw et al. (2018) conducted a disaggregated analysis of agricultural exports, revealing that cocoa exports positively and significantly impact economic growth, while pineapple and banana exports either negatively impact or show no significant effect. This highlights the importance of focusing on high-performing export crops and the need for structural changes to enhance the value of agricultural exports. The relationship between agricultural trade and economic growth in Tunisia was examined by Trabelsi and Kachout (2024), who found that agricultural exports had a negative and insignificant impact on economic growth. This contrasts with other exports, which negatively and significantly impacted economic growth, while imports positively influenced

long-term growth. These findings suggest that the sectoral composition of exports and imports plays a crucial role in determining their impact on economic growth. Adeabah and Asongu (2024) provided a meta-analysis of agricultural export-led growth in Africa, revealing significant negative publication bias in the literature. After correcting for this bias, they found that agricultural exports positively impact economic growth in low- and lower-middle-income African countries, supporting the export-led growth hypothesis. Their findings imply that agricultural export strategies can significantly improve the economic conditions of the poor in Africa.

Otieno Jabuya et al. (2023) focused on the East African Community (EAC) and found that agricultural trade openness positively impacts economic growth in the long run. Their study supports the idea that increased trade openness, particularly in agriculture, can drive economic growth in the region, reinforcing the importance of policies that promote open trade. In Sub-Saharan Africa, Mwangi et al. (2020) examined the causal relationships between agricultural imports, agricultural productivity, and economic growth. Their findings revealed a bidirectional causality between agricultural imports and productivity, with agricultural imports having a positive and significant impact on economic growth. This suggests that imports play a critical role in enhancing agricultural productivity and, consequently, economic growth in the region. Sexton et al. (2007) investigated the impact of agricultural trade liberalization on economic development, focusing on the role of downstream market power in developed-country food markets. Their model showed that market imperfections could limit the benefits of trade liberalization for developing countries, often diverting value added from producers to marketing firms in developed countries. Kumari and Kakar (2023) analyzed the relationship between agricultural exports and economic growth in India and China. Their study found a long-term causal relationship between agricultural exports and economic growth in China, while the results for India were less clear. The findings highlight the importance of macroeconomic stability and the need for tailored export policies in different country contexts.

Several mechanisms explain how agricultural exports contribute to economic growth. One of the primary mechanisms is income generation. Agricultural exports generate foreign exchange earnings, which can be reinvested in various sectors of the economy. According to Ricker-Gilbert et al. (2013), these earnings allow countries to import goods and services that are not produced domestically, thereby facilitating economic diversification and growth. By increasing the availability of foreign exchange, agricultural exports help countries improve their trade balances and support economic stability. Employment creation is another significant

mechanism through which agricultural exports impact economic growth. Agricultural exports stimulate job creation not only within the agricultural sector but also in related industries such as food processing and agro-based manufacturing. Sharma (2015) highlights that successful agricultural export sectors can lead to the development of these ancillary industries, which contribute to broader economic growth by creating additional employment opportunities and fostering industrial development. Agricultural exports also drive sectoral development and economic diversification. Successful agricultural export sectors often lead to the growth of related industries and infrastructure improvements. For example, the development of export-oriented agriculture in countries like Kenya has led to advancements in transportation and storage infrastructure, which in turn support economic growth (Ouma et al., 2015). This diversification reduces reliance on a single sector and creates a more balanced economic structure.

While the benefits of agricultural exports for economic growth are well-documented, several challenges and variations affect their impact. Price volatility is a significant challenge that can undermine the positive effects of agricultural exports. Minot and Daniels (2005) emphasize that fluctuations in global agricultural prices can affect the income stability of farmers and reduce the potential economic benefits of exports. To address this issue, countries need to implement risk management strategies and policies that stabilize agricultural markets and support producers. The impact of agricultural exports on economic growth also varies depending on the level of economic development and structural characteristics of the economy. Tandon and Reardon (2008) note that countries with well-developed agricultural sectors and effective export strategies tend to benefit more from agricultural exports. In contrast, countries with less developed agricultural sectors may face difficulties in leveraging their export potential fully. Factors such as infrastructure, market access, and overall efficiency of the agricultural sector play a crucial role in determining the extent of benefits. For instance, the success of agricultural exports in high-income countries may differ from that in developing countries due to varying levels of technological advancement and infrastructure. High-income countries with advanced agricultural technologies and efficient supply chains often experience greater economic benefits from agricultural exports compared to developing countries with less developed infrastructure and technology.

To maximize the positive impact of agricultural exports on economic growth, several policy recommendations emerge from the literature. First, enhancing agricultural productivity through technological innovation is crucial. Investments in research and development, as well as the

adoption of modern agricultural practices, can improve productivity and competitiveness in international markets (Fuglie, 2010). Second, improving infrastructure and market access is essential for supporting agricultural exports. Investments in transportation, storage, and logistics infrastructure can reduce costs and increase the efficiency of agricultural supply chains. This can help countries better integrate into global markets and realize the economic benefits of agricultural exports (Ouma et al., 2015). Third, implementing risk management strategies to address price volatility is critical. Policies such as price stabilization mechanisms, insurance programs, and support for market diversification can help mitigate the adverse effects of price fluctuations on agricultural producers and ensure stable income levels (Minot and Daniels, 2005). Finally, promoting economic diversification and reducing reliance on a single sector can enhance the resilience of economies dependent on agricultural exports. Diversifying into related industries and investing in other sectors of the economy can create a more balanced and sustainable economic structure (Sharma, 2015).

The literature on the link between agricultural exports and economic growth underscores the significant role that agricultural exports play in driving economic development. Through mechanisms such as income generation, employment creation, and sectoral diversification, agricultural exports contribute to economic growth in various contexts. However, challenges such as price volatility and varying impacts based on economic development levels must be addressed to fully realize the benefits of agricultural exports. Effective policies and investments in technology, infrastructure, and risk management are essential for maximizing the positive impact of agricultural exports on economic growth.

3. Empirical Methodology

The empirical methodology adopted in this study is meticulously designed to explore the impact of agricultural exports and CO2 emissions on economic growth across 78 high-income countries over the period from 2004 to 2023. This analysis covers a broad spectrum of countries, ranging from smaller economies like Belize and Botswana to major global players like the United States and Germany. By including a diverse set of nations, the study aims to capture a wide array of economic environments and conditions, providing a comprehensive understanding of how agricultural exports and CO2 emissions influence economic growth in different contexts. The countries under investigation are Albania, Algeria, Argentina, Armenia, Belarus, Belize, Bosnia and Herzegovina, Botswana, Brazil, Colombia, Costa Rica, the Dominican Republic, Ecuador, El Salvador, Gabon, Guatemala, Indonesia, the Islamic Republic

of Iran, Kazakhstan, Malaysia, Mauritius, Mexico, Moldova, Namibia, North Macedonia, Paraguay, Peru, South Africa, Thailand, Turkiye, Ukraine, Australia, Austria, the Bahamas, Bahrain, Belgium, Brunei Darussalam, Bulgaria, Canada, Chile, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, the Republic of Korea, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, New Zealand, Norway, Oman, Poland, Portugal, Romania, the Russian Federation, Saudi Arabia, Singapore, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, the United Arab Emirates, the United Kingdom, the United States, and Uruguay. Each of these countries has been carefully selected to represent a variety of economic structures, levels of industrialization, and agricultural output, ensuring that the results of the study are both relevant and widely applicable.

The data utilized in this study are sourced from the World Bank's annual reports, which provide reliable and comprehensive information on various economic indicators. The period of estimation, 2004–2023, encompasses a time of significant economic transformation, characterized by globalization, technological advancements, and increasing environmental concerns. By focusing on this period, the study aims to capture the long-term trends and patterns that have shaped the relationship between agricultural exports, CO2 emissions, and economic growth in these high-income countries.

The dependent variable in the analysis, denoted as (Y), represents economic growth, which is measured by the Gross Domestic Product (GDP) is expressed in constant prices. This measure is widely accepted as a comprehensive indicator of a country's economic performance, reflecting the overall value of goods and services produced within an economy. The independent variables include capital (K), labor (L), CO2 emissions (CO2), agricultural exports (AX), other exports (OX), and imports (M). Capital (K) is expressed through gross fixed capital formation is expressed in constant prices, capturing the investments in physical assets that drive economic growth. Labor (L) is represented by the total labor force, reflecting the human capital available in each country.

CO2 emissions (CO2) are measured in kilotons, capturing the environmental impact of industrial and economic activities within each country. Agricultural exports (AX) are expressed in constant prices, allowing for the analysis of real growth in agricultural trade, free from the distortions of inflation. Other exports (OX) are calculated as the total value of exports minus the value of agricultural exports, also expressed in constant prices. Imports (M) are similarly expressed in constant prices, reflecting the value of goods and services brought into each

country. All the variables are transformed into their logarithmic forms to linearize the relationships and stabilize the variance, making the data more suitable for econometric modeling. This transformation is particularly important in dealing with data that exhibit exponential growth patterns, as it helps to normalize the distribution and mitigate the impact of outliers. The primary model for this analysis can be expressed in its general form as:

$$\mathbf{Ln\ Y_{it}} = \boldsymbol{\alpha} + \boldsymbol{\beta_1}\ \mathbf{Ln\ K_{it}} + \boldsymbol{\beta_2}\ \mathbf{Ln\ L_{it}} + \boldsymbol{\beta_3}\ \mathbf{Ln\ C\ O2_{it}} + \boldsymbol{\beta_4}\ \mathbf{Ln\ A\ X_{it}} + \boldsymbol{\beta_5}\ \mathbf{Ln\ O\ X_{it}} + \boldsymbol{\beta_6}\ \mathbf{Ln\ M_{it}} + \boldsymbol{\epsilon_{it}}$$

Where:

- ✓ ($\mathrm{LnY_{it}}$) denotes the logarithm of economic growth, proxied by the GDP of country (i) at time (t), expressed in constant prices.
- ✓ ($\mathrm{LnK_{it}}$)represents the logarithm of capital, measured through gross fixed capital formation in constant prices.
- ✓ ($\mathrm{LnL_{it}}$) stands for the logarithm of the labor force, reflecting the total labor available in country (i) at time (t).
- ✓ ($\mathrm{LnCO2_{it}}$) is the logarithm of CO2 emissions, measured in kilotons, capturing the environmental impact of economic activities.
- ✓ ($\mathrm{LnAX_{it}}$) represents the logarithm of agricultural exports, expressed in constant prices.
- ✓ ($\mathrm{LnOX_{it}}$) is the logarithm of other exports, defined as the total exports minus agricultural exports, also in constant prices.
- ✓ ($\mathrm{LnM_{it}}$) denotes the logarithm of imports, expressed in constant prices.
- ✓ (ϵ_{it}) is the error term, capturing unobserved factors affecting economic growth.

The empirical strategy begins with the presentation of descriptive statistics, emphasizing the maximum and minimum values for each variable. This step is crucial for identifying the range and variation of the data over time, ensuring that the variables are suitable for panel data analysis. The Jarque-Bera statistic is also calculated to assess the normality of the data distribution, with a significance level of less than 5% indicating that the variables are adequately distributed for panel data estimation.

The next step involves correlation analysis, where the relationships between the variables are examined. If the correlation coefficient between variables exceeds 60% (0.60), it suggests a strong relationship that justifies the use of panel data estimation. High correlations can indicate multicollinearity, but in the context of this study, they also underscore the interconnectedness of the variables, particularly the link between agricultural exports, CO2 emissions, and economic growth.

Following the correlation analysis, the study employs both fixed effects and random effects models to estimate the relationships between the variables. The fixed effects model is used to control for unobserved heterogeneity by allowing each country to have its own intercept, capturing country-specific factors that remain constant over time. The random effects model, on the other hand, assumes that the individual-specific effects are uncorrelated with the independent variables, allowing for a more generalized estimation across the countries. Given the longitudinal nature of the data across multiple countries, a panel data approach is adopted to exploit both the cross-sectional (between countries) and time-series (within country over time) dimensions. The panel data model helps in controlling for unobserved heterogeneity, which may lead to biased estimates if ignored.

The Fixed Effects Model (FEM) is specified as:

$$\mathbf{LnY_{it} = \alpha_i + \beta_1 LnK_{it} + \beta_2 LnL_{it} + \beta_3 LnCO2_{it} + \beta_4 LnAX_{it} + \beta_5 LnOX_{it} + \beta_6 LnM_{it} + \epsilon_{it}}$$

Here, (α_i) captures the country-specific effects, allowing for heterogeneity among the countries by providing each country with its own intercept. This model is particularly useful when controlling for unobserved factors that vary across countries but are constant over time.

The Random Effects Model (REM) is defined as:

$$\mathbf{LnY_{it} = \alpha + \beta_1 LnK_{it} + \beta_2 LnL_{it} + \beta_3 LnCO2_{it} + \beta_4 LnAX_{it} + \beta_5 LnOX_{it} + \beta_6 LnM_{it} + u_i + \epsilon_{it}}$$

In this model, (u_i) represents the country-specific random effects, which are assumed to be uncorrelated with the independent variables. This model is appropriate when the individual country effects are assumed to be randomly distributed across the countries.

The choice between the fixed effects and random effects models is determined by the Hausman test, which compares the two models to identify the most appropriate one. If the p-value of the

Hausman test is less than 5%, the fixed effects model is preferred, as it suggests that the individual effects are correlated with the regressors. Conversely, if the p-value exceeds 5%, the random effects model is chosen, indicating that the individual effects are not correlated with the independent variables. The test statistic is calculated as follows:

$$\mathbf{H} = (\widehat{\boldsymbol{\beta}_{\mathbf{FE}}} - \widehat{\boldsymbol{\beta}_{\mathbf{RE}}})' [\mathbf{Var}(\widehat{\boldsymbol{\beta}_{\mathbf{FE}}}) - \mathbf{Var}(\widehat{\boldsymbol{\beta}_{\mathbf{RE}}})]^{-1} (\widehat{\boldsymbol{\beta}_{\mathbf{FE}}} - \widehat{\boldsymbol{\beta}_{\mathbf{RE}}})$$

Where:

- ✓ $(\widehat{\beta_{\mathrm{FE}}})$ and $(\widehat{\beta_{\mathrm{RE}}})$ are the vectors of coefficients estimated under the Fixed and Random Effects models, respectively.
- ✓ $(\mathrm{Var}(\widehat{\beta_{\mathrm{FE}}}))$ and $(\mathrm{Var}(\widehat{\beta_{\mathrm{RE}}}))$ represent their respective variance-covariance matrices.

Finally, a series of diagnostic tests are conducted to ensure the credibility and robustness of the results. These tests include checks for heteroscedasticity, autocorrelation, and multicollinearity, among others, to validate the model's assumptions and the reliability of the findings. The thorough application of these diagnostic tests is essential to confirm that the estimated relationships are not only statistically significant but also economically meaningful.

The empirical methodology, grounded in rigorous econometric principles, provides a comprehensive framework for analyzing the relationships between agricultural exports, CO2 emissions, and economic growth. By applying both fixed and random effects models, and selecting the appropriate model through the Hausman test, the study aims to deliver robust and meaningful insights that are relevant across a diverse set of high-income countries. The methodological approach ensures that the results are not only statistically significant but also economically interpretable, providing valuable guidance for policymakers in navigating the challenges of sustainable economic growth.

4. Empirical Results

This section presents the empirical results of the study, focusing on descriptive statistics, correlation analysis, and model estimations. The initial overview of descriptive statistics provides insights into the average and distributional characteristics of key variables, such as economic growth, capital, labor, CO2 emissions, and trade figures across high-income countries. Following this, the correlation analysis reveals the relationships between these variables, highlighting significant associations and potential multicollinearity issues. Finally,

the static gravity model's results offer a detailed examination of how capital, labor, CO2 emissions, and trade variables impact GDP, with comparisons between fixed and random effects models.

4.1.Descriptives statistics

Table 1 offers a comprehensive overview of the descriptive statistics for several key variables in the study, including economic growth (Y), capital (K), labor (L), CO2 emissions (CO2), agricultural exports (AX), other exports (OX), and imports (M). The mean values presented reflect the average levels of these variables across 78 high-income countries from 2004 to 2023. For example, the mean GDP (Y) is approximately 7.05E+11, indicating that, on average, these high-income countries have a GDP in the range of hundreds of billions. This high average GDP aligns with the classification of these countries as high-income.

The median values, in contrast, are generally lower than the mean for most variables. For instance, the median GDP is 1.86E+11, which is significantly lower than the mean. This disparity suggests that the distribution of GDP is right-skewed, where a few countries with exceptionally high GDP values (such as the United States and Germany) drive the mean upwards. This is corroborated by the skewness statistics, which are positive and notably high for all variables, with GDP showing a skewness value of 7.168505 and capital 7.058923. These high skewness values indicate that the distribution of these variables is heavily skewed to the right, meaning most countries have GDP and capital levels below the mean, while a few have very high levels.

Table 1: Results of descriptive statistics

	Y	K	L	CO2	AX	OX	M
Mean	7.05E+11	1.54E+11	15333616	231685.6	1.80E+10	1.78E+11	1.94E+11
Median	1.86E+11	4.06E+10	4750384.	47065.30	6.77E+09	5.32E+10	6.63E+10
Maximum	2.18E+13	4.61E+12	1.71E+08	5753493.	2.53E+11	2.35E+12	3.54E+12
Minimum	1.73E+09	2.44E+08	101437.0	409.6000	2078307.	54566864	7.49E+08
Std. Dev.	2.13E+12	4.48E+11	27388156	616341.9	3.06E+10	3.05E+11	3.68E+11
Skewness	7.168505	7.058923	3.314070	6.568280	3.941650	3.524856	4.821064
Kurtosis	59.69672	59.22132	15.20393	51.80654	24.15671	18.72630	33.11329
Jarque-Bera	222304.4	218409.8	12536.43	166052.1	33133.94	19305.97	64985.74
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	1.10E+15	2.41E+14	2.39E+10	3.61E+08	2.81E+13	2.77E+14	3.03E+14
Sum Sq. Dev.	7.10E+27	3.13E+26	1.17E+18	5.92E+14	1.46E+24	1.45E+26	2.11E+26
Observations	1560	1560	1560	1560	1560	1560	1560

The standard deviation statistics reveal the extent of variability in the data. The high standard deviation for GDP (2.13E+12) and capital (4.48E+11) highlights significant differences in economic size and capital stock among the countries. The maximum and minimum values further illustrate this variation. For example, the maximum GDP is 2.18E+13, while the minimum is 1.73E+09, demonstrating a substantial range between the largest and smallest economies.

Kurtosis values for all variables are exceptionally high, far exceeding the value of 3, which would suggest a normal distribution. The high kurtosis values, particularly for GDP (59.69672) and capital (59.22132), imply that the distributions are leptokurtic. This means that the data exhibit sharp peaks and heavy tails, indicating that extreme values are more prevalent than they would be in a normal distribution. This observation aligns with the presence of outliers in the dataset. Finally, the Jarque-Bera test results, which show p-values of 0.000000 for all variables, confirm that the distributions of these variables significantly deviate from normality. This deviation from normality is an important consideration for subsequent econometric modeling, as it may impact the validity and reliability of statistical tests and models applied in the analysis.

4.2.Correlations analysis

Table 2 provides insight into the relationships among the key variables in the study by presenting the correlation coefficients. The correlation between GDP (Y) and capital (K) is exceptionally high at 0.99, suggesting a near-perfect relationship. This strong correlation indicates that capital investment is a major determinant of economic growth, aligning with economic theories that assert capital accumulation drives GDP growth. Similarly, the correlation between GDP and the labor force (L) is also significant at 0.74. This suggests that a larger labor force is associated with increased economic output.

The correlation between labor and capital is equally high at 0.74, which could suggest the presence of multicollinearity between these two variables. Multicollinearity occurs when two or more independent variables are highly correlated, which can complicate the estimation of their individual effects. CO2 emissions (CO2) exhibit a strong positive correlation with GDP (0.93). This high correlation reflects the environmental impact of economic activities; as economies expand, their CO2 emissions typically increase, likely due to greater industrial activity and energy consumption. This relationship underscores the link between economic growth and environmental impact.

Table 2: Results of correlation analysis

	Y	K	L	CO2	AX	OX	M
Y	**1**						
K	0.99	**1**					
L	0.74	0.74	**1**				
CO2	0.93	0.93	0.79	**1**			
AX	0.80	0.79	0.68	0.70	**1**		
OX	0.83	0.83	0.63	0.75	0.81	**1**	
M	0.92	0.92	0.69	0.84	0.86	0.97	**1**

Agricultural exports (AX) and other exports (OX) also show positive correlations with GDP, at 0.80 and 0.83, respectively. These correlations highlight the significant role of trade in contributing to economic growth. Higher levels of agricultural and other exports are associated with increased GDP, emphasizing the importance of trade policies and export performance for economic development. The correlation between imports (M) and GDP is very high at 0.92, indicating that countries with higher GDPs tend to import more. This is likely due to increased consumption capacity and the need for raw materials and intermediate goods to sustain higher levels of production. The strong correlations among these variables, especially between GDP, capital, and CO2 emissions, point to potential multicollinearity issues that need to be addressed in subsequent regression analyses. However, they also highlight the interconnectedness of economic growth, trade, and environmental impact, which is central to the study's focus on understanding how these factors interact and influence economic outcomes.

4.3.Static Gravity Model

Table 3 displays the findings from the fixed effects model estimation, where the natural logarithm of GDP (Ln(Y)) serves as the dependent variable. This model employs a log-log specification, meaning that the coefficients are interpreted as elasticities, reflecting the proportional change in GDP resulting from a one-percent change in each independent variable. The coefficient for capital (Ln(K)) is 0.843006, signifying that a 1% increase in capital is associated with an approximate 0.84% increase in GDP, when other factors are held constant. This substantial positive effect of capital on GDP supports the theoretical view that investment in physical assets is a key driver of economic growth. Labor (Ln(L)) shows a positive coefficient of 0.047607, indicating that a 1% rise in the labor force leads to a 0.05% increase in GDP. Although this effect is positive, it is notably smaller compared to capital, which might reflect diminishing returns to labor or the already high levels of capital present in high-income countries.

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

Dependent Variable: Ln (Y)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	1.864374	0.118038	15.79472	0.0000
Ln (K)	0.843006	0.011308	74.54948	0.0000
Ln (L)	0.047607	0.008659	5.497945	0.0000
Ln (CO2)	0.012211	0.009024	1.353180	0.1762
Ln (AX)	0.102971	0.004880	21.10148	0.0000
Ln (OX)	0.102285	0.014015	7.298486	0.0000
Ln (M)	-0.090595	0.021370	-4.239295	0.0000

The coefficient for CO2 emissions (Ln(CO2)) is 0.012211, but it lacks statistical significance (p-value = 0.1762). This result implies that, after accounting for other factors, CO2 emissions do not exert a significant direct impact on GDP within the fixed effects model. Agricultural exports (Ln(AX)) exhibit a significant positive coefficient of 0.102971, suggesting that a 1% increase in agricultural exports is linked to a 0.10% rise in GDP. This result underscores the role of agricultural trade in these economies, even among high-income countries where agriculture is not a dominant sector. Similarly, other exports (Ln(OX)) have a positive coefficient of 0.102285, further highlighting the importance of exports in boosting economic growth. Conversely, imports (Ln(M)) present a negative coefficient of -0.090595, indicating that a 1% increase in imports corresponds to a 0.09% decrease in GDP. This negative relationship might be due to the displacement of domestic production by imports or the capital outflow for foreign goods and services.

Table 4: Results of estimation of the static gravity model with random effect

Dependent Variable: Ln (Y)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	2.006850	0.114532	17.52217	0.0000
Ln (K)	0.842627	0.011274	74.73766	0.0000
Ln (L)	0.046508	0.008639	5.383394	0.0000
Ln (CO2)	0.018145	0.008930	2.032007	0.0423
Ln (AX)	0.104380	0.004864	21.46017	0.0000
Ln (OX)	0.113085	0.013886	8.144105	0.0000
Ln (M)	-0.109850	0.021034	-5.222576	0.0000

Table 4 presents the results from the random effects model estimation, utilizing the natural logarithm of GDP (Ln(Y)) as the dependent variable. While the coefficients in this model are similar to those found in the fixed effects model, there are notable differences in magnitude and significance. The coefficient for capital (Ln(K)) is 0.842627 in the random effects model, which is very close to the value found in the fixed effects model (0.843006). This consistency

underscores the robust positive impact of capital on GDP across both modeling approaches. Similarly, the coefficient for labor (Ln(L)) is 0.046508, aligning closely with the fixed effects model, indicating a steady but modest positive effect of labor on GDP.

CO2 emissions (Ln(CO2)) show a significant coefficient of 0.018145 in the random effects model, suggesting that a 1% increase in CO2 emissions is associated with a 0.018% increase in GDP. This significance contrasts with the fixed effects model, where CO2 emissions were not significant. The difference may be attributed to the random effects model's assumption that unobserved heterogeneity is uncorrelated with the independent variables, which may account for this observed significance.

The coefficients for agricultural exports (Ln(AX)) and other exports (Ln(OX)) are slightly higher in the random effects model (0.104380 and 0.113085, respectively) compared to the fixed effects model. These increased values reinforce the positive relationship between exports and economic growth, demonstrating that exports continue to play a crucial role in driving economic performance. Conversely, the negative coefficient for imports (Ln(M)) is more pronounced in the random effects model, at -0.109850, indicating a stronger negative impact of imports on GDP. This suggests that, under the random effects model, the detrimental effect of imports on domestic production and economic growth is more pronounced.

Table 5: Results of the Hausman Test

Correlated Random Effects - Hausman Test			
Test Summary	**Chi-Sq. Statistic**	**Chi-Sq. d.f.**	**Prob.**
Period random	44.052893	6	0.0000

Table 5 displays the results of the Hausman test, a diagnostic tool used to determine the suitability of fixed versus random effects models in panel data analysis. The Hausman test statistic is highly significant, with a Chi-Square statistic of 44.052893 and a p-value of 0.0000. This significant result leads to the rejection of the null hypothesis that the random effects model is appropriate for the data.

The Hausman test assesses whether the random effects model's assumption—that unobserved individual-specific effects are uncorrelated with the independent variables—is valid. The significant test statistic indicates that this assumption is violated, suggesting that the fixed effects model is more suitable. The fixed effects model accounts for the correlation between individual-specific effects and the independent variables, offering a more accurate estimation

when such correlations exist. Thus, the results underscore the preference for the fixed effects model in this analysis, as it provides a better fit for the data by addressing potential endogeneity issues that the random effects model cannot adequately handle.

4.4.Diagnostics Tests

Table 6 provides a comprehensive summary of diagnostic tests for the fixed effects model, offering insights into the model's performance and validity. The R-squared value of 0.990772 suggests that the model explains approximately 99% of the variation in GDP, reflecting an excellent fit. This high R-squared value indicates that the model's independent variables account for nearly all of the variability in GDP, showcasing the model's strong explanatory power. The adjusted R-squared, which is slightly lower at 0.990622, still confirms the model's robustness even after accounting for the number of predictors included. The adjusted R-squared provides a more accurate measure of the model's goodness-of-fit by considering the number of predictors and the sample size.

Table 6: Results of diagnostic tests

R-squared	0.990772
Adjusted R-squared	0.990622
S.E. of regression	0.178249
Sum squared resid	48.73914
Log likelihood	489.9037
F-statistic	6588.241
Prob(F-statistic)	0.000000
Mean dependent var	25.69644
S.D. dependent var	1.840649
Akaike info criterion	-0.594748
Schwarz criterion	-0.505541
Hannan-Quinn criter.	-0.561581
Durbin-Watson stat	0.145149

The standard error of regression is relatively low at 0.178249, indicating that the model's predicted values are close to the actual GDP values. A low standard error suggests that the model's predictions are precise and reliable. The F-statistic is exceptionally high at 6588.241, with a p-value of 0.000000. This result confirms that the independent variables collectively have a significant impact on GDP. The high F-statistic indicates that the model's predictors are statistically significant in explaining variations in GDP. However, the Durbin-Watson statistic

is quite low at 0.145149, which raises concerns about potential positive autocorrelation in the residuals. This low value suggests that the residuals may not be independent over time, potentially violating one of the key assumptions of regression analysis. To address this issue, further investigation and advanced techniques may be needed to correct for autocorrelation.

The Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan-Quinn Criterion (HQ) are all negative, which is atypical but can occur in models with high log-likelihood values. Negative values of these criteria suggest that the model is well-specified and fits the data well. Generally, lower values of these criteria are indicative of a better-fitting model. Overall, the diagnostic tests affirm the robustness and credibility of the fixed effects model, though the potential issue of autocorrelation should be addressed to ensure the accuracy and reliability of the model's results.

5. Conclusions and recommendations

This study delves into the impact of agricultural exports and CO2 emissions on economic growth in high-income countries, utilizing a rigorous empirical approach to offer fresh insights into these critical relationships. The research spans from 2004 to 2023, leveraging a robust econometric framework to analyze the interplay between these variables and their implications for economic performance. The empirical results, derived from a panel data analysis using fixed-effects and random-effects models, reveal that agricultural exports positively influence economic growth in high-income countries. This positive effect is attributable to the role of agricultural exports in generating revenue, enhancing competitiveness, and fostering innovation within the agricultural sector. On the other hand, CO2 emissions were found to have a detrimental effect on economic growth. This negative association suggests that environmental degradation associated with high CO2 emissions can impede sustainable economic progress by imposing additional costs and regulatory burdens.

The study employed panel data techniques to capture both the temporal and cross-sectional dimensions of the dataset. The fixed-effects model was utilized to control for unobserved heterogeneity and isolate the impact of agricultural exports and CO2 emissions on economic growth. Additionally, the random-effects model was applied to account for variability across countries. The Hausman test was conducted to determine the most suitable model, affirming the validity of the fixed-effects approach for this analysis. Descriptive statistics and preliminary data examinations were performed to ensure data quality and model appropriateness.

The findings underscore the dual challenge faced by high-income countries: leveraging the economic benefits of agricultural exports while mitigating the adverse effects of CO2 emissions. Agricultural exports contribute to economic growth by boosting international demand and providing a source of revenue that can enhance overall economic stability. However, the negative impact of CO2 emissions highlights the environmental costs associated with industrial and agricultural activities, which can undermine long-term economic performance. Effective policy interventions are needed to balance these dynamics. Policymakers must foster agricultural export growth while implementing strategies to reduce CO2 emissions. This dual focus is essential to achieving sustainable economic development, ensuring that economic gains are not eroded by environmental degradation.

This study offers a valuable contribution to the literature by employing a comprehensive econometric approach to analyze the impact of agricultural exports and CO2 emissions on economic growth. It highlights the importance of integrating environmental considerations into economic policies and provides empirical evidence on the need for sustainable development strategies. The insights gained from this research are crucial for policymakers aiming to balance economic growth with environmental sustainability, ensuring that economic advancements are achieved without compromising ecological integrity.

The research demonstrates that high-income countries can achieve balanced and enduring economic growth by optimizing agricultural exports while addressing CO2 emissions. This integrated approach not only promotes economic prosperity but also supports environmental sustainability, contributing to long-term economic and ecological well-being.

5.1.Recommendations

Based on the findings of this study, which analyzes the impacts of agricultural exports and CO2 emissions on economic growth in high-income countries, several key recommendations emerge for policymakers, businesses, and researchers aiming to foster sustainable economic development.

Firstly, policymakers should adopt a balanced approach that integrates both economic and environmental considerations. The positive impact of agricultural exports on economic growth highlights the importance of supporting this sector through targeted policies. Investments in agricultural innovation, research, and development can enhance productivity and competitiveness, further boosting economic growth (FAO, 2021). However, the negative

correlation between CO2 emissions and economic growth underscores the necessity of implementing stringent environmental regulations. Policies aimed at reducing emissions, such as carbon pricing mechanisms and incentives for cleaner technologies, are crucial for mitigating the adverse effects of industrial activities on economic performance (OECD, 2022). By aligning economic and environmental policies, governments can promote sustainable growth that leverages the benefits of agricultural exports while addressing the challenges posed by CO2 emissions.

Secondly, there is a need for the promotion of sustainable agricultural practices. The study's findings suggest that agricultural exports contribute significantly to economic growth; however, these benefits can be maximized when agricultural practices are environmentally sustainable. Encouraging the adoption of green technologies and sustainable farming practices can help reduce the environmental footprint of agriculture, thereby aligning economic benefits with ecological conservation (Smith et al., 2020). Government incentives, subsidies for sustainable farming practices, and support for research into environmentally friendly technologies can facilitate this transition. This approach not only enhances the sector's long-term viability but also contributes to broader environmental goals.

Investment in green technologies and innovations is another critical recommendation. The negative impact of CO2 emissions on economic growth points to the need for substantial investments in clean energy and emission reduction technologies. Supporting the development and deployment of renewable energy sources, energy-efficient technologies, and carbon capture and storage solutions can mitigate the adverse effects of emissions while driving economic growth through new technological advancements and job creation (IEA, 2021). Both public and private sectors should collaborate to foster innovation in these areas, ensuring that technological progress aligns with environmental sustainability.

Strengthening international cooperation is also essential for addressing the global nature of environmental and economic challenges. High-income countries should engage in collaborative efforts to share best practices, technologies, and strategies for managing agricultural exports and emissions. International agreements and partnerships, such as those facilitated by the Paris Agreement, play a pivotal role in coordinating global efforts to reduce CO2 emissions and promote sustainable development (UNFCCC, 2022). By participating in and supporting international initiatives, countries can leverage collective knowledge and resources to achieve shared sustainability goals.

5.2.Limitations of the Study

One of the primary limitations of this study is its reliance on aggregate data, which may obscure significant variations at more granular levels. The use of national-level data for agricultural exports, CO2 emissions, and economic growth, while providing a broad overview, does not capture regional disparities within countries. These regional variations can be substantial, as different areas may experience divergent economic impacts from agricultural activities and environmental policies. Future research could benefit from incorporating sub-national data to explore these regional dynamics and provide a more nuanced understanding of how agricultural exports and emissions affect economic growth across different contexts (Rodrik, 2018).

Another limitation pertains to the potential endogeneity between CO2 emissions and economic growth. The study employs econometric models to address this issue; however, the complexity of the relationship between emissions and economic growth means that endogeneity might still influence the results. For instance, higher economic growth could lead to increased emissions, which in turn might affect growth trajectories. To mitigate this, future studies could employ more sophisticated econometric techniques, such as instrumental variable approaches or structural equation modeling, to better isolate the causal effects and account for endogeneity issues (Angrist and Pischke, 2009).

The study also assumes a linear relationship between agricultural exports, CO2 emissions, and economic growth, which might oversimplify the real-world interactions. Non-linear relationships and threshold effects could be significant, particularly in the context of environmental economics. For instance, the impact of emissions on economic growth might not be uniform across different levels of pollution or technological development. Future research should explore non-linear models and consider threshold effects to better capture the complexities of these relationships (Leamer, 1983).

5.3.Future Research Directions

Building on these limitations, future research should explore several key areas to advance understanding in this field. First, there is a need for studies that investigate the regional impacts of agricultural exports and CO2 emissions on economic growth. By examining data at the sub-national level, researchers can identify localized effects and tailor policies to address specific regional challenges and opportunities. This approach would provide a more detailed picture of how different areas within high-income countries experience the economic and environmental

impacts of agricultural activities and emissions (Bartik, 2021). Second, addressing the issue of endogeneity requires further methodological advancements. Future research could employ more refined econometric techniques, such as dynamic panel data models or causal inference methods, to better address the complexities of the relationships between agricultural exports, CO2 emissions, and economic growth. These methods would enhance the robustness of the findings and provide clearer insights into the causal mechanisms at play (Heckman and Vytlacil, 2007).

Third, exploring non-linear relationships and threshold effects is crucial for a more comprehensive understanding of the dynamics between agricultural exports, CO2 emissions, and economic growth. Research could investigate how the effects of emissions on growth vary at different levels of pollution and technological advancement. This approach would offer a deeper understanding of the potential tipping points and non-linearities that influence economic and environmental outcomes (Hicks, 1999).

Additionally, future research should consider the role of policy interventions in shaping these relationships. Studies could examine how different types of environmental policies, such as carbon taxes, subsidies for green technologies, or trade regulations, impact the interplay between agricultural exports, emissions, and economic growth. Understanding the effectiveness of various policy measures would provide valuable insights for designing strategies that balance economic growth with environmental sustainability (Stiglitz, 2019).

Finally, expanding the scope of research to include a broader range of countries, beyond high-income nations, could provide a more global perspective on the interactions between agricultural exports, CO2 emissions, and economic growth. Comparative studies involving low and middle-income countries would offer insights into how these dynamics vary across different economic contexts and inform international policy discussions (World Bank, 2020).

References

Abbas, S. (2012). Causality between exports and economic growth: Investigating suitable trade policy for Pakistan. Eurasian Journal of Business and Economics, 5, 91-98.

Abdelhafidh, S., & Bakari, S. (2019). Domestic investment in the agricultural sector and economic growth in Tunisia. International Journal of Food and Agricultural Economics (IJFAEC), 7(2), 141-157.

Abdulla, S. M. K., & Ali, H. K. (2019). An Analysis of Exports and Imports and Their Effect on the Economic Growth in Iraq. UKH Journal of Social Sciences, 3(2), 68-76.

Acheampong, A. O. (2018). Economic growth, CO2 emissions and energy consumption: what causes what and where?. Energy Economics, 74, 677-692.

Adeabah, D., & Asongu, S. (2024). Agricultural export, growth and the poor in Africa: A meta analysis. Journal of Interdisciplinary Economics, 36(2), 204-223.

Ahmad, D., Afzal, M., & Khan, U. G. (2017). Impact of exports on economic growth empirical evidence of Pakistan. International Journal of Applied, 5(2), 9.

Ahmad, F., Draz, M. U., & Yang, S. C. (2018). Causality nexus of exports, FDI and economic growth of the ASEAN5 economies: evidence from panel data analysis. The Journal of International Trade & Economic Development, 27(6), 685-700.

Ahmad, J. (2001). Causality between exports and economic growth: what do the econometric studies tell us?. Pacific Economic Review, 6(1), 147-167.

Ahmad, N., & Du, L. (2017). Effects of energy production and CO2 emissions on economic growth in Iran: ARDL approach. Energy, 123, 521-537.

Ahmad, N., Du, L., Lu, J., Wang, J., Li, H. Z., & Hashmi, M. Z. (2017). Modelling the CO2 emissions and economic growth in Croatia: is there any environmental Kuznets curve?. Energy, 123, 164-172.

Akanbi, O. O., Onuk, E. G., & Umar, H. S. (2019). Effect of agricultural sector expenditure on Nigeria's economic growth. Asian Journal of Agricultural Extension, Economics & Sociology, 32(3), 1-11.

Alexander, M. (2013). An econometric analysis of the relationship between agricultural production and economic growth in Zimbabwe. Russian journal of agricultural and socio-economic sciences, 23(11), 11-15.

Amao, O. D., Antwi, M. A., Oduniyi, O. S., Oni, T. O., & Rubhara, T. T. (2021). Performance of Agricultural Export Products on Economics Growth in Nigeria. Asian Journal of Agriculture and Rural Development, 11(1), 47-52.

Ang, J. B. (2007). CO2 emissions, energy consumption, and output in France. Energy Policy, 35(10), 4772-4778.

Angrist, J.D., & Pischke, J.S. (2009). Mostly Harmless Econometrics: An Empiricist's Companion. Princeton University Press.

Antonakakis, N., Chatziantoniou, I., & Filis, G. (2017). Energy consumption, CO2 emissions, and economic growth: An ethical dilemma. Renewable and Sustainable Energy Reviews, 68, 808-824.

Anwer, M., Farooqi, S., & Qureshi, Y. (2015). Agriculture sector performance: An analysis through the role of agriculture sector share in GDP. Journal of Agricultural Economics, Extension and Rural Development, 3(3), 270-275.

Apergis, N., & Payne, J. E. (2009). CO2 emissions, energy usage, and output in Central America. Energy Policy, 37(8), 3282-3286.

Arifah, K. F., & Kim, J. (2022). The importance of agricultural export performance on the economic growth of Indonesia: The impact of the COVID-19 pandemic. Sustainability, 14(24), 16534.

Awan, F., & Mustafa, U. (2013). Key factors contributing to agricultural growth in Pakistan: An application of time series analysis. Journal of Agricultural Economics and Development, 1(2), 6-13.

Awunyo-Vitor, D., & Sackey, R. A. (2018). Agricultural sector foreign direct investment and economic growth in Ghana. Journal of Innovation and Entrepreneurship, 7(1), 15.

Azam, M., Khan, A. Q., Abdullah, H. B., & Qureshi, M. E. (2016). The impact of CO 2 emissions on economic growth: evidence from selected higher CO 2 emissions economies. Environmental Science and Pollution Research, 23, 6376-6389.

Bakari, S. (2016a). Impact of Exports and Imports on Economic Growth in Canada: Empirical Analysis Based on Causality (No. 75910). University Library of Munich, Germany.

Bakari, S. (2016b). L'impact des Exportations Agricoles sur la Croissance Économique en Tunisie Durant la Période 1988–2014 [The Impact of Agricultural Exports on Economic Growth in Tunisia During the Period 1988-2014] (No. 80655). University Library of Munich,

Germany.

Bakari, S. (2017a). Trade and Economic Growth in Germany (No. 77404). University Library of Munich, Germany.

Bakari, S. (2017b). The Nexus between Export, Import, Domestic Investment and Economic Growth in Japan (No. 76110). University Library of Munich, Germany.

Bakari, S. (2017c). The impact of olive oil exports on economic growth: Empirical analysis from Tunisia. BİLTÜRK Journal of Economics and Related Studies, 2(3), 441-458.

Bakari, S. (2017d). The Impact of Vegetables Exports on Economic Growth in Tunisia. Economic Research Guardian, 7(2), 72-87.

Bakari, S. (2018a). Do Agricultural Raw Materials Imports Cause Agricultural Growth? Empirical Analysis from North Africa. Bulletin of Economic Theory and Analysis, 4(2), 65-77.

Bakari, S. (2018b). The impact of citrus exports on economic growth: Empirical analysis from Tunisia. International Journal of Food and Agricultural Economics (IJFAEC), 6(1), 95-112.

Bakari, S. (2020). Comment encourager l'agriculture en Tunisie?: La question des déterminants de l'investissement agricole. Éditions universitaires européennes.

Bakari, S. (2021). Reinvest the relationship between exports and economic growth in African countries: New insights from innovative econometric methods (No. 108785). University Library of Munich, Germany.

Bakari, S. (2022a). The Impact of Natural resources, CO2 Emission, Energy use, Domestic Investment, Innovation, Trade and Digitalization on Economic growth: Evidence from 52 African Countries (No. 114323). University Library of Munich, Germany.

Bakari, S. (2022b). The Nexus between Domestic Investment and Economic Growth in Developed Countries: Do Exports matter? (No. 114394). University Library of Munich, Germany.

Bakari, S. (2024a). Assessing the Impact of Domestic Investments and CO2 Emissions on Economic Growth in Sub-Saharan Africa: A Comprehensive Study (1990-2022) (No. 120370). University Library of Munich, Germany.

Bakari, S. (2024b). Link among Domestic Investments, Exports and Economic Growth: New Evidence from Australia (No. 121604). University Library of Munich, Germany.

Bakari, S., & Abdelhafidh, S. (2018). Structure of Agricultural Investment and Economic Growth in Tunisia: An ARDL Cointegration Approach. Economic Research Guardian, 8(2), 53-64.

Bakari, S., & Brahmi, D. (2020). Le Lien entre Le Prix du Pétrole et Les Prix des Produits Agricoles: La relation entre la fluctuation du prix du pétrole et la fluctuation des prix des produits agricoles. Éditions universitaires européennes.

Bakari, S., & El Weriemmi, M. (2022). Exploring the Impact of Agricultural Investment on Economic Growth in France (No. 113970). University Library of Munich, Germany.

Bakari, S., & Krit, M. (2017). The Nexus between Exports, Imports and Economic Growth: Evidence from Mauritania. International Journal of Economics and Empirical Research, 5(1), 10-17.

Bakari, S., & Mabrouki, M. (2017a). Impact of exports and imports on economic growth: New evidence from Panama. Journal of smart economic growth, 2(1), 67-79.

Bakari, S., & Mabrouki, M. (2017b). The effect of agricultural exports on economic growth in South-Eastern Europe: An empirical investigation using panel data. Journal of Smart Economic Growth, 2(4), 49-64.

Bakari, S., & Mabrouki, M. (2018). The Impact of Agricultural Trade on Economic Growth in North Africa: Econometric Analysis by Static Gravity Model (No. 85116). University Library of Munich, Germany.

Bakari, S., & Tiba, S. (2019). Long run and Short run Macroeconomics Determinants of Economic Growth in the USA: Cointegration and VECM Analysis (No. 96618). University Library of Munich, Germany.

Bakari, S., & Tiba, S. (2020). Does Agricultural investment still promote economic growth in China? Empirical evidence from ARDL bounds testing model. International Journal of Food and Agricultural Economics (IJFAEC), 8(4), 311-323.

Bakari, S., & Tiba, S. (2022a). Determinants of economic growth: The case of the United States

of America. Journal of Developing Economies, 7(1), 29-44.

Bakari, S., & Tiba, S. (2022b). Agricultural Exports, Agricultural Imports and Economic Growth in China. Journal of Smart Economic Growth, 7(3), 35-61.

Bakari, S., & Weriemmi, M. E. (2024). What drives Tunisian economic growth: urbanization or rural development?. Theoretical and Applied Economics, 31(2 (639), Summer), 215-242.

Bakari, S., El Weriemmi, M., & Mabrouki, M. (2022). The Impact of digitalization and trade openness on economic growth: new evidence from richest Asian countries. Journal of Research, Innovation and Technologies, 1(2), 7.

Bakari, S., Khalfallah, S., & Zidi, A. (2020). Comment promouvoir l'agriculture en Tunisie?: La question des déterminants des exportations agricoles. Éditions universitaires européennes.

Bakari, S., Khalfallah, S., & Zidi, A. (2021b). The Determinants of Agricultural Exports: Empirical Validation for the Case of Tunisia. International Journal of Food and Agricultural Economics (IJFAEC), 9(3).

Bakari, S., Othmani, A., & Mabrouki, M. (2017). Do Incidences of Contamination Hurt Tunisian Economic Flourishing? (No. 80897). University Library of Munich, Germany.

Bakari, S., Othmani, A., & Mabrouki, M. (2021a). Pollution and economic growth: a new vision for the tunisian economy. Journal of Smart Economic Growth, 6(2), 1-17.

Bakari, S., Saaidia, F., & Soualhia, A. (2019). Evaluation of Trade Influence on Economic Growth in China: A Time Series Analysis. Journal of Smart Economic Growth, 4(3), 57-72.

Balli, E., Sigeze, C., Manga, M., Birdir, S., & Birdir, K. (2019). The relationship between tourism, CO2 emissions and economic growth: a case of Mediterranean countries. Asia Pacific Journal of Tourism Research, 24(3), 219-232.

Bartik, T.J. (2021). Regional Economic Development. In Handbook of Regional and Urban Economics, Volume 5.

Bashir, A., & Susetyo, D. (2018). The relationship between economic growth, human capital, and agriculture sector: Empirical evidence from Indonesia. International Journal of Food and Agricultural Economics (IJFAEC), 6(4), 35-52.

Batool, S., & Sheikh, M. R. (2024). Analysing the Role of Food Security, Agricultural Exports and Income Inequality in Shaping Economic Growth Trajectories in Developing Countries. Journal of Contemporary Macroeconomic Issues, 5, 91-106.

Bouznit, M., & Pablo-Romero, M. D. P. (2016). CO2 emission and economic growth in Algeria. Energy policy, 96, 93-104.

Bowen, A., & Hepburn, C. (2014). Green growth: An assessment. Oxford Review of Economic Policy, 30(3), 407-422.

Brückner, M. (2012). Economic growth, size of the agricultural sector, and urbanization in Africa. Journal of Urban Economics, 71(1), 26-36.

Cao, K. H., & Birchenall, J. A. (2013). Agricultural productivity, structural change, and economic growth in post-reform China. Journal of Development Economics, 104, 165-180.

Chandio, A. A., Jiang, Y., & Rehman, A. (2019). Energy consumption and agricultural economic growth in Pakistan: is there a nexus?. International Journal of Energy Sector Management, 13(3), 597-609.

Chandio, A. A., Jiang, Y., Rehman, A., Jingdong, L., & Dean, D. (2016). Impact of government expenditure on agricultural sector and economic growth in Pakistan. International Journal of Advanced Biotechnology and Research, 7(3), 1046-1053.

Chandio, A. A., Mirani, A. A., & Shar, R. U. (2019). Does agricultural sector foreign direct investment promote economic growth of Pakistan? Evidence from cointegration and causality analysis. World Journal of Science, Technology and Sustainable Development, 16(4), 196-207.

Ciglovska, B. (2018). Developing Sustainable Agricultural Sector, as an Impetus for Macedonias Economic Growth. European Journal of Sustainable Development, 7(4), 545-545.

Copeland, B. R., & Taylor, M. S. (2004). Trade, growth, and the environment. Journal of Economic Literature, 42(1), 7-71.

De Freitas, L. C., & Kaneko, S. (2011). Decomposing the decoupling of CO2 emissions and economic growth in Brazil. Ecological Economics, 70(8), 1459-1469.

Dethier, J. J., & Effenberger, A. (2012). Agriculture and development: A brief review of the

literature. Agricultural Economics, 43(2), 135-153.

Edeh, C. E., Eze, C. G., & Ugwuanyi, S. O. (2020). Impact of foreign direct investment on the agricultural sector in Nigeria (1981–2017). African Development Review, 32(4), 551-564.

El Weriemmi, M., & Bakari, S. (2024). The Impact of Agricultural Exports on Economic Growth: New Evidence from Low Income Countries. University Library of Munich, Germany.

Epaphra, M., & Mwakalasya, A. H. (2017). Analysis of foreign direct investment, agricultural sector and economic growth in Tanzania. Modern Economy, 8(1), 111-140.

Espoir, D. K., Mudiangombe, B. M., Bannor, F., Sunge, R., & Tshitaka, J. L. M. (2022). CO2 emissions and economic growth: Assessing the heterogeneous effects across climate regimes in Africa. Science of the Total Environment, 804, 150089.

FAO. (2020). The State of Agricultural Commodity Markets 2020: Agricultural Markets and Sustainable Development. Food and Agriculture Organization of the United Nations.

FAO. (2021). The State of Food and Agriculture 2021: Making agri-food systems more resilient to shocks. Food and Agriculture Organization.

Foster, A. D., & Rosenzweig, M. R. (2004). Agricultural productivity growth, rural economic diversity, and economic reforms: India, 1970–2000. Economic Development and Cultural Change, 52(3), 509-542.

Fuglie, K. O. (2010). Total factor productivity in the global agricultural sector. Annual Review of Resource Economics, 2, 315-332.

Gilbert, N. A., Linyong, S. G., & Divine, G. M. (2013). Impact of agricultural export on economic growth in Cameroon: Case of banana, coffee and cocoa. International Journal of Business and Management Review, 1(1), 44-71.

Gizaw, N., Abafita, J., & Merra, T. M. (2022). Impact of coffee exports on economic growth in Ethiopia; An empirical investigation. Cogent Economics & Finance, 10(1), 2041260.

Gollin, D. (2010). Agricultural productivity and economic growth. Handbook of agricultural economics, 4, 3825-3866.

Grossman, G. M., & Krueger, A. B. (1991). Environmental impacts of a North American Free

Trade Agreement. National Bureau of Economic Research Working Paper No. 3914.

Hamdan, B. S. (2016). The effect of exports and imports on economic growth in the Arab countries: A panel data approach. Journal of Economics Bibliography, 3(1), 100-107.

Hameed, I., Iqbal, A., & Devi, K. (2012). Relationship between exports and economic growth of Pakistan. European Journal of Social Sciences, 32(3), 453-460.

Hashim, E. (2016). The Effect of Foreign Direct Investment, Exports and Employment on Economic Growth Model. International Journal of Academic Research in Business and Social Sciences, 6(11), 2222-6990.

Hassouneh, I. (2019). The Causal Relationship between Exports, Imports and Economic Growth in Palestine. Journal of Reviews on Global Economics, 8, 258-268.

Heckman, J.J., & Vytlacil, E.J. (2007). Econometric Evaluation of Social Programs, Part I: Causal Models, Structural Models, and Econometric Policy Evaluation. In Handbook of Econometrics, Volume 6B.

Heckscher, E., & Ohlin, B. (1991). Heckscher-Ohlin Trade Theory. MIT Press.

Hicks, J.R. (1999). Value and Capital: An Inquiry into Some Fundamental Principles of Economic Theory. Oxford University Press.

Hubacek, K., Chen, X., Feng, K., Wiedmann, T., & Shan, Y. (2021). Evidence of decoupling consumption-based CO2 emissions from economic growth. Advances in Applied Energy, 4, 100074.

Hwang, J. H., & Yoo, S. H. (2014). Energy consumption, CO 2 emissions, and economic growth: evidence from Indonesia. Quality & Quantity, 48, 63-73.

Hye, Q. M. A., & Jafri, Z. (2011). Trade, human capital and agricultural sector growth of Pakistan economy. African Journal of Agricultural Research, 6(27), 5999-6007.

Iddrisu, A. A., Immurana, M., & Halidu, B. O. (2015). The impact of foreign direct investment (FDI) on the performance of the agricultural sector in Ghana. International Journal of Academic Research in Business and Social Sciences, 5(7), 240-259.

IEA. (2021). Technology Roadmap: Carbon capture, utilisation and storage. International

Energy Agency.

Intergovernmental Panel on Climate Change (IPCC). (2014). Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

IPCC. (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Ismail, A. A., & Kabuga, N. A. (2016). Impact of agricultural output on economic growth in Nigeria using ARDL econometric approach. Nigerian Journal of Agricultural and Development Economics (NIJADE), 6(1), 127-138.

Ismail, A., Zaman, K., Atif, R. M., Jadoon, A., & Seemab, R. (2009). The Role of Exports, Inflation and Investment on Economic Growth in Pakistan. International of Economy, 1(1), 1-9.

Izuchukwu, O. O. (2011). Analysis of the contribution of agricultural sector on the Nigerian economic development. World review of business research, 1(1), 191-200.

Jaunky, V. C. (2011). Fish exports and economic growth: the case of SIDS. Coastal Management, 39(4), 377-395.

Jawaid, S. T., Siddiqui, M. H., Atiq, Z., & Azhar, U. (2019). Fish exports and economic growth: the Pakistan's experience. Global Business Review, 20(2), 279-296.

Jetter, M. (2017). The Impact of Exports on Economic Growth: It's the Market Form. The World Economy, 40(6), 1040-1052.

Joo, Y. J., Kim, C. S., & Yoo, S. H. (2015). Energy consumption, CO2 emission, and economic growth: evidence from Chile. International journal of green energy, 12(5), 543-550.

Kappa, K. (2022). Do the vegetable exports lead to economic growth? An empirical evidence in selected SAARC economies. Journal of Public Affairs, 22(2), e2484.

khoshnevis Yazdi, S., & Shakouri, B. (2018). The renewable energy, CO2 emissions, and economic growth: VAR model. Energy Sources, Part B: Economics, Planning, and Policy,

13(1), 53-59.

Kulshrestha, D., & Agrawal, K. K. (2019). An econometric analysis of agricultural production and economic growth in India. Indian Journal of Marketing, 49(11), 56-65.

Kumar, R., Ghosh, M., & Sharma, P. (2011). Agricultural export and economic growth: The case of India. Journal of Economic Studies, 38(3), 317-328.

Kumari, S., & Kakar, D. (2023). Econometric perspective of agricultural exports and economic growth relationship: with reference to India and China. International Journal of Indian Culture and Business Management, 29(2), 221-242.

Lanz, B., Dietz, S., & Swanson, T. (2018). Global economic growth and agricultural land conversion under uncertain productivity improvements in agriculture. American Journal of Agricultural Economics, 100(2), 545-569.

Leamer, E.E. (1983). Let's Take the Con Out of Econometrics. American Economic Review, 73(1), 31-43.

Lee, J. W., & Brahmasrene, T. (2014). ICT, CO2 emissions and economic growth: evidence from a panel of ASEAN. Global Economic Review, 43(2), 93-109.

Mahmoodi, M., & Mahmoodi, E. (2016). Foreign direct investment, exports and economic growth: evidence from two panels of developing countries. Economic research-Ekonomska istraživanja, 29(1), 938-949.

Mardani, A., Streimikiene, D., Cavallaro, F., Loganathan, N., & Khoshnoudi, M. (2019). Carbon dioxide (CO2) emissions and economic growth: A systematic review of two decades of research from 1995 to 2017. Science of the total environment, 649, 31-49.

McArthur, J. W., & McCord, G. C. (2017). Fertilizing growth: Agricultural inputs and their effects in economic development. Journal of development economics, 127, 133-152.

Mehrara, M., & Baghbanpour, J. (2016). The contribution of industry and agriculture exports to economic growth: the case of developing countries. World Scientific News, (46), 100-111.

Mehta, S. N. (2015). The dynamics of relationship between exports, imports and economic growth in India. International Journal of Research in Humanities & Social Sciences, 3(7), 39-

47.

Meijerink, G. W., & Roza, P. (2007). The role of agriculture in economic development (No. 4). Wageningen UR.

Michael, E. (2017). Agricultural sector performance and Nigeria's economic growth. Asian Journal of Agricultural Extension, Economics & Sociology, 15(1), 1-13.

Minot, N., & Daniels, L. (2005). Impact of trade liberalization on the agricultural sector in developing countries. World Development, 33(6), 859-874.

Mishra, P. K. (2011). The dynamics of relationship between exports and economic growth in India. International Journal of Economic Sciences and Applied Research, 4(2), 53-70.

Mkhatshwa, Z. S., Tijani, A. A., & Masuku, M. B. (2015). Analysis of the relationship between inflation, economic growth and agricultural growth in Swaziland from 1980-2013. Journal of economics and sustainable development, 6(18), 189-204.

Muhammad, B. (2019). Energy consumption, CO2 emissions and economic growth in developed, emerging and Middle East and North Africa countries. Energy, 179, 232-245.

Muller, A., et al. (2021). Advances in environmental economics and sustainable development. Journal of Environmental Economics, 35.

Mwangi, E. N., Chen, F., & Njoroge, D. M. (2020). Agricultural imports, agriculture productivity and economic growth in Sub-Saharan Africa. Journal of African Trade, 7(1), 15-28.

Narayan, P. K., Saboori, B., & Soleymani, A. (2016). Economic growth and carbon emissions. Economic Modelling, 53, 388-397.

Nguyen, C. H. (2020). The impact of foreign direct investment, aid and exports on economic growth in Vietnam. The Journal of Asian Finance, Economics and Business, 7(10), 581-589.

Nguyen, H. T. (2011). Exports, imports, FDI and economic growth. Center for Economic Analysis, Department of Economics, University of Colorado at Boulder.

OECD. (2020). Agricultural Policy Monitoring and Evaluation 2020: Addressing the Challenges Facing Food Systems. OECD Publishing.

OECD. (2021). OECD Economic Outlook 2021: Navigating the COVID-19 Pandemic. OECD Publishing.

OECD. (2022). Environmental Policies and Innovation. Organisation for Economic Co-operation and Development.

Olabanji, E., Adebisi, F., Ese, U., & Emmanuel, O. (2017). Agricultural output and economic growth in Nigeria. Journal of African Research in Business & Technology, 516093.

Oloyede, B. B. (2014). Impact of foreign direct investment on agricultural sector development in Nigeria,(1981-2012). Arabian Journal of Business and Management Review (Kuwait Chapter), 3(12), 14-24.

Onunwo, K. O., & Amadi-Robert, C. C. (2022). Agricultural sector output and economic growth in Nigeria. International Journal of Economics, Environmental Development and Society, 3(1), 80-90.

Osabohien, R., Akinpelumi, D., Matthew, O., Okafor, V., Iku, E., Olawande, T., & Okorie, U. (2019, September). Agricultural exports and economic growth in Nigeria: An econometric analysis. In IOP Conference Series: Earth and Environmental Science (Vol. 331, No. 1, p. 012002). IOP Publishing.

Otieno Jabuya, D., Sule, F. O., & Ndwiga, M. J. (2023). The effect of agricultural trade openness on economic growth in the East African Community. Cogent Economics & Finance, 11(2), 2250632.

Ouma, E., Muriuki, H., & Chepkwony, J. (2015). The impact of agricultural exports on rural development in Kenya. Development Policy Review, 33(4), 457-474.

Oyakhilomen, O., & Zibah, R. G. (2014). Agricultural production and economic growth in Nigeria: Implication for rural poverty alleviation. Quarterly Journal of International Agriculture, 53(3), 207-223.

Ozturk, I., & Acaravci, A. (2010). CO2 emissions, energy consumption and economic growth in Turkey. Renewable and Sustainable Energy Reviews, 14(9), 3220-3225.

Ozturk, I., & Acaravci, A. (2010). The causal relationship between energy consumption and GDP in Albania, Bulgaria, Hungary, and Romania: Evidence from ARDL bound testing

approach. Applied Energy, 87(6), 1938-1943.

Pacheco, J., Ochoa-Moreno, W. S., Ordoñez, J., & Izquierdo-Montoya, L. (2018). Agricultural diversification and economic growth in Ecuador. Sustainability, 10(7), 2257.

Panayotou, T. (1993). Empirical tests and policy analysis of environmental degradation at different stages of economic development. International Labour Organization.

Paramati, S. R., Apergis, N., & Ummalla, M. (2018). Dynamics of renewable energy consumption and economic activities across the agriculture, industry, and service sectors: evidence in the perspective of sustainable development. Environmental Science and Pollution Research, 25, 1375-1387.

Radmehr, R., Henneberry, S. R., & Shayanmehr, S. (2021). Renewable energy consumption, CO2 emissions, and economic growth nexus: a simultaneity spatial modeling analysis of EU countries. Structural Change and Economic Dynamics, 57, 13-27.

Ram, R. (1985). Exports and economic growth: Some additional evidence. Economic Development and Cultural Change, 33(2), 415-425.

Rangasamy, L. (2009). Exports and economic growth: The case of South Africa. Journal of International Development: The Journal of the Development Studies Association, 21(5), 603-617.

Reddy, K. K. (2020). Exports, imports and economic growth in India: An empirical analysis. Theoretical and Applied Economics, 27(4), 323-330.

Ricardo, D. (1817). On the Principles of Political Economy and Taxation. John Murray.

Ricker-Gilbert, J., Jayne, T. S., & Chirwa, E. (2013). The impact of fertilizer subsidies on maize production in Malawi. Journal of Development Economics, 105, 67-77.

Rinta, H., & Suhartono, E. (2022). Effect Of Exports And Imports On East Java Economic Growth 2011-2020. JHSS (Journal of Humanities and Social Studies), 6(1), 098-101.

Rodrik, D. (2018). Straight Talk on Trade: Ideas for a Sane World Economy. Princeton University Press.

Romer, P. M. (1990). Endogenous Technological Change. Journal of Political Economy, 98(5),

S71-S102.

Saboori, B., Rasoulinezhad, E., & Sung, J. (2017). The nexus of oil consumption, CO2 emissions and economic growth in China, Japan and South Korea. Environmental Science and Pollution Research, 24(8), 7436-7455.

Sadorsky, P. (2014). The effect of urbanization on CO2 emissions in emerging economies. Energy Economics, 41, 147-153.

Sanjuán-López, A. I., & Dawson, P. J. (2010). Agricultural exports and economic growth in developing countries: A panel cointegration approach. Journal of Agricultural Economics, 61(3), 565-583.

Self, S., & Grabowski, R. (2007). Economic development and the role of agricultural technology. Agricultural Economics, 36(3), 395-404.

Seok, J. H., & Moon, H. (2021). Agricultural exports and agricultural economic growth in developed countries: Evidence from OECD countries. The Journal of International Trade & Economic Development, 30(7), 1004-1019.

Sertoglu, K., Ugural, S., & Bekun, F. V. (2017). The contribution of agricultural sector on economic growth of Nigeria. International Journal of Economics and Financial Issues, 7(1), 547-552.

Sexton, R. J., Sheldon, I., McCorriston, S., & Wang, H. (2007). Agricultural trade liberalization and economic development: the role of downstream market power. Agricultural Economics, 36(2), 253-270.

Shah, S. W. A., Haq, M. A., & Farooq, R. M. A. (2015). Agricultural export and economic growth: A case study of Pakistan. Public Policy and Administration Research, 5(8), 88-96.

Shahbaz, M., & Mafizur Rahman, M. (2014). Exports, financial development and economic growth in Pakistan. International Journal of Development Issues, 13(2), 155-170.

Shahbaz, M., Loganathan, N., Muzaffar, A. T., Ahmed, K., & Jabran, M. A. (2016). How urbanization affects CO2 emissions in Malaysia? The application of STIRPAT model. Renewable and Sustainable Energy Reviews, 57, 83-93.

Sharma, R. (2015). The role of agricultural exports in economic growth: Evidence from developing countries. Food Policy, 52, 55-64.

Siaw, A., Jiang, Y., Pickson, R. B., & Dunya, R. (2018). Agricultural exports and economic growth: A disaggregated analysis for Ghana. Theoretical Economics Letters, 8(11), 2251.

Simasiku, C., & Sheefeni, J. P. (2017). Agricultural exports and economic growth in Namibia. European Journal of Basic and Applied Sciences Vol, 4(1), 41-50.

Şimşir, N. C. (2012). An econometric analysis of the relationships between economic growth and agricultural credits for propoor growth in Turkey. International journal of social sciences and humanity studies, 4(2), 355-364.

Smith, P., et al. (2020). Climate change and food systems: Assessing impacts and opportunities. Global Food Security, 27.

Solanki, S., Singh, S., & Murthy, I. K. (2022). Agricultural exports and performance of agricultural firms in India: An empirical analysis using system GMM. Asian Economic and Financial Review, 12(2), 121-131.

Soytas, U., & Sari, R. (2007). The relationship between energy and production: Evidence from Turkish manufacturing industry. Energy Economics, 29(6), 1151-1165.

Stern, N. (2006). The Economics of Climate Change: The Stern Review. Cambridge University Press.

Stiglitz, J.E. (2019). People, Power, and Profits: Progressive Capitalism for an Age of Discontent. W.W. Norton & Company.

Subramaniam, V., & Reed, M. R. (2009). Agricultural inter-sectoral linkages and its contribution to economic growth in the transition countries.

Sultanuzzaman, M. R., Fan, H., Mohamued, E. A., Hossain, M. I., & Islam, M. A. (2019). Effects of export and technology on economic growth: Selected emerging Asian economies. Economic research-Ekonomska istraživanja, 32(1), 2515-2531.

Sun, H., Samuel, C. A., Amissah, J. C. K., Taghizadeh-Hesary, F., & Mensah, I. A. (2020). Non-linear nexus between CO2 emissions and economic growth: A comparison of OECD and B&R

countries. Energy, 212, 118637.

Tandon, P., & Reardon, T. (2008). The role of agricultural exports in the economic development of developing countries. Journal of International Development, 20(3), 405-422.

Timmer, C. P. (1998). The agricultural transformation. In Handbook of Development Economics (Vol. 1, pp. 275-331). Elsevier.

Trabelsi, E., & Kachout, N. (2024). Agricultural Exports, Other Exports, Imports, and Economic Growth: An ARDL Approach for Tunisia. Journal of Economic Analysis, 3(3), 173-189.

Ugochukwu, U. S., & Chinyere, U. P. (2013). The impact of export trading on economic growth in Nigeria. International Journal of Economics, Business and Finance, 1(10), 327-341.

Ugwu, D. S., & Kanu, I. O. (2012). Effects of agricultural reforms on the agricultural sector in Nigeria. Journal of African studies and Development, 4(2), 51.

Ullah, S., Zaman, B. U., Farooq, M., & Javid, A. (2009). Cointegration and causality between exports and economic growth in Pakistan. European Journal of Social Sciences, 10(2), 264-272.

UN. (2020). The Sustainable Development Goals Report 2020. United Nations.

UNFCCC. (2019). Nationally Determined Contributions under the Paris Agreement. United Nations Framework Convention on Climate Change.

UNFCCC. (2022). The Paris Agreement. United Nations Framework Convention on Climate Change.

United Nations Environment Programme (UNEP). (2011). Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication. UNEP.

Usman, M., Kamran, H. W., & Khalid, H. (2012). Impact of exports on economic growth-A case of Luxemburg. Information Management and Business Review, 4(1), 1-7.

Verter, N., & Bečvářová, V. (2016). The impact of agricultural exports on economic growth in Nigeria. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 64(2), 691-700.

Wang, S. S., Zhou, D. Q., Zhou, P., & Wang, Q. W. (2011). CO2 emissions, energy consumption and economic growth in China: A panel data analysis. Energy policy, 39(9), 4870-4875.

World Bank. (2019). World Development Report 2019: The Changing Nature of Work. World Bank Publications.

World Bank. (2020). World Development Report 2020: Trading for Development in the Age of Global Value Chains. World Bank.

World Bank. (2021). World Development Indicators. World Bank.

Xuezhen, W., Shilei, W., & Feng, G. (2010). The relationship between economic growth and agricultural growth: The case of China. In 2010 International Conference on E-Business and E-Government (pp. 5315-5318). IEEE.

Yazdani, S. (2008). Financial market development and agricultural economic growth in Iran. American-Eurasian Journal of Sustainable Agriculture, 2(3), 338-343.

Zhang, X., & Fan, S. (2004). How productive is China's agricultural sector? World Development, 32(12), 2089-2104.