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题目 **A study on Climate Change, Institutional Quality and International Trade: Evidence from African economies**

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DECLARATION

I, KAOUTAR RAISSI hereby declare that apart from the references which have been properly quoted, the work presented in this thesis **"A study on climate change, institutional quality and international trade: evidence from African economies"** was conducted fully by me under the supervision of Miss Zhang in the Department of Economics and Management, Anhui Polytechnic University, from March 2023 to May 2024. This thesis is not published or submitted either in part or whole anywhere for the award of a degree in any other university.

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This work has been submitted for examination with our approval as supervisors.

XIUQIN ZHANG ……. … May 15,2025……

(supervisor) (Signature) (Date)

DEDICATION

I dedicate this thesis work to my parent Mr. Abdollah Raissi & Mrs. Fadma Abakouche and my friend Mr. Muneef Fahmi.

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I am deeply grateful to Almighty God for His wisdom, divine favor, and the abundant grace that has guided me from the beginning to the successful completion of this thesis.

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摘要

这项研究探讨了气候变化、制度质量和国际贸易之间的复杂关系，特别关注治理结构在环境挑战背景下如何影响贸易结果。研究分析了 2019 至 2022 年的数据，结合了制度效能的关键指标，如监管质量、政治稳定性和贸易自由度。通过分析这些制度维度如何在气候变化背景下塑造贸易模式，研究探讨了制度在减缓和加剧环境挑战对贸易影响方面的双重作用。它突出了治理框架在决定气候变化对选定非洲国家贸易动态影响程度中的关键作用。通过使用先进的计量经济学模型，研究为制度质量和环境因素之间的相互作用提供了宝贵的见解，并提出了旨在增强贸易韧性的政策建议。这些建议强调了加强治理体系以支持可持续贸易实践并应对气候变化长期影响的必要性。研究结果为非洲如何制定稳健的贸易政策提供了新视角，平衡经济增长、环境可持续性和制度效能，揭示了制度质量如何在应对日益增长的环境挑战时塑造具有韧性和适应性的贸易战略。

关键词：国际贸易，监管质量，环境挑战，贸易自由

ABSTRACT

This study investigates the complex relationship between climate change, institutional quality, and international trade in Africa, with a particular focus on how governance structures influence trade outcomes amidst environmental challenges. The research examines data from 2019 to 2022, incorporating key indicators of institutional effectiveness such as regulatory quality, political stability, and trade freedom. By analyzing how these institutional dimensions shape trade patterns in the context of climate change, the study explores the dual role of institutions in both mitigating and exacerbating the impact of environmental challenges on trade. It highlights the critical role of governance frameworks in determining the extent to which climate change influences trade dynamics across selected African countries. Using advanced econometric models, the study provides valuable insights into the interplay between institutional quality and environmental factors, offering policy recommendations aimed at enhancing trade resilience. These recommendations emphasize the need for strengthening governance systems to support sustainable trade practices and address the long-term effects of climate change. The findings contribute to the ongoing discourse on how to develop robust trade policies in Africa that balance economic growth, environmental sustainability, and institutional effectiveness, offering new perspectives on how institutional quality can shape resilient and adaptive trade strategies in the face of growing environmental challenges.

***Keywords**: International trade, Regulatory quality, Environmental Challenges, Trade Freedom*

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LIST OF ABBREVIATION

WTO	World Trade Organization
GDP	Gross Domestic Product
WGI	World Governance Indicators
CO_2	Carbon Dioxide
POP	Population
WTO	World Trade Organization
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
EKC	Environmental Kuznets Curve
GHG	Greenhouse Gases
JEEM	Journal of Environmental Economics and Management
JDE	Journal of Development Economics
WGI	Worldwide Governance Indicators
IQ	Institutional Quality
WDI	World Development Indicators
TFI	Trade Freedom Index
PS	Political Stability
RQ	Regulatory Quality
RE	Random Effects
SDGs	Sustainable Development Goals

CHAPTER 1 INTRODUCTION

1.1 Research Background of the Study

International trade has seen notable fluctuations influenced by shifting global dynamics, policy developments, and structural constraints. From 2010 to 2019, global trade volumes grew steadily, supported by technological advancements and the expansion of global value chains. According to the World Trade Organization (WTO), global merchandise trade grew at an average annual rate of 2.5% during this period. However, the COVID-19 pandemic in 2020 led to a sharp 5.3% contraction in global trade, exposing the fragility of supply chains. Recovery began in 2021, with global trade rebounding by 9.8%, but was soon challenged again by the Russia–Ukraine conflict and rising geopolitical tensions. In 2023, the WTO projected global merchandise trade growth to slow to 1.7% due to weakening demand, protectionist policies, and inflationary pressures.

African economies, which collectively account for about 3% of global trade, have faced persistent difficulties in expanding and diversifying their exports. According to the African Export-Import Bank (Afreximbank), intra-African trade stood at only 15.2% of total African exports in 2022, compared to over 60% in Europe and Asia. Most African countries continue to rely on a narrow range of commodities—for instance, oil accounts for over 90% of Nigeria's exports, while copper dominates Zambia's export profile. Between 2010 and 2023, Africa's GDP increased from approximately $2 trillion to over $3 trillion (World Bank data), yet the benefits of trade have remained unevenly distributed due to structural challenges, including underdeveloped infrastructure, high logistics costs, and institutional inefficiencies.

Furthermore, Studies have asserted that along with gross domestic product, factors like climate change and institutional quality significantly influence the capacity of African countries to integrate into global markets.

Climate change poses an additional layer of complexity. Africa is one of the most climate-vulnerable regions despite contributing less than 4% of global greenhouse gas emissions. Data from the African Development Bank show that between 2010 and 2022, the continent experienced over 170 extreme weather events per year on average, including severe droughts in the Horn of Africa, floods

in West and Central Africa, and rising temperatures affecting agricultural productivity. Agriculture, which employs more than 60% of the African labor force and contributes significantly to exports, is particularly affected. Climate-related disruptions have direct trade implications by damaging transport infrastructure, lowering crop yields, and increasing the volatility of export revenues.

In this context, institutional quality is a vital enabler of trade performance and climate resilience. The World Governance Indicators (WGI) measure institutional quality using dimensions such as regulatory quality and political stability. Between 2010 and 2022, most African countries scored below the global average on both indicators. For example, Sub-Saharan Africa's average score for regulatory quality remained between -0.8 and -0.6 (on a scale of -2.5 to +2.5), reflecting persistent governance weaknesses. Countries like Rwanda and Botswana performed relatively well, while others, such as the Democratic Republic of Congo and Somalia, struggled with severe institutional deficits. Strong institutions are crucial for enforcing contracts, managing climate risks, coordinating public investment, and fostering investor confidence—thus directly and indirectly shaping trade outcomes.

1.2 Research questions

1- To what extent does institutional quality contribute to influence international trade in African economies?

2-What's the relationships between exports, imports, climate change, GDP per capita, regulatory quality, political stability and economic freedom?

3-How's the combined effect of institutional quality and climate change on international trade

1.3 Objective of the study

The general objective of the study is to is to investigate the intricate relationships between institutional quality, climate change and international trade that exist between certain African countries. However, to achieve this objective, it is therefore important to sub-divide the study objectives into specific objectives.

The specific objectives of the study are:

1. Investigate the relationship between climate change and institutional quality on trade.
2. Investigate the long and short-run relationship between independent variables on international trade.
3. Seeks to identify the impact of climate change on trade in the african countries.
4. Explore policy that can be used to facilitate the intricate relationships between institutional quality, climate change and international trade.

1.4 Significance of the study

This study is important as it highlights the urgent need for African countries to balance international trade growth with environmental sustainability and strong institutions. In recent years, climate change has become a critical challenge that affects trade performance, agricultural exports, and infrastructure development across the continent. By examining the role of institutional quality and environmental factors in shaping trade outcomes, this study encourages governments and policymakers to integrate climate resilience and good governance into their trade strategies.

The research will provide valuable insights into how improving institutional quality—such as regulatory quality and political stability—can help reduce the negative impacts of climate change on trade. It also offers knowledge on how African economies can benefit from global trade while adapting to environmental challenges. Furthermore, this study emphasizes the importance of developing cleaner and more efficient trade systems, which can help reduce emissions and promote sustainable economic growth.

1.5 Scope of the study

This study is conducted in African countries, focusing on the relationship between international trade, institutional quality, and climate change. Africa is a region with growing trade potential, yet it remains vulnerable to climate change impacts and institutional weaknesses. The study covers data from 2010 onward, examining how trade flows are influenced by global temperature and institutional factors like regulatory quality and political stability. This focus helps understand how Africa can strengthen trade while adapting to climate challenges and improving governance.

1.6 Contribution of the study

This study contributes to the existing literature by exploring the interconnected roles of international trade, institutional quality, and climate change

in the context of African economies—an area that remains underexplored. By focusing on recent data and combining economic, environmental, and governance dimensions, the study offers new insights into how institutional reforms and climate resilience can enhance trade performance. The findings will inform policymakers and development agencies on how to design integrated strategies that promote sustainable trade and economic growth in Africa.

1.7 Research methodology

We obtained the data from Comtrade Database, World Governance Indicators, Environmental Performance Index, World Bank, World Development Indicators, and the Freedom Index. We used a balanced dataset for Panel data from 2010 to 2022, and covers a selected sample of African countries. The data on exports, imports, GDP, POP, regulatory quality, political stability, economic freedom and climate change. this study uses various econometric methods. For this purpose, STATAMP 17 software is used to perform both diagnostic and econometric tests. The analysis begins with descriptive statistics, which summarize key characteristics of the data. Next, a series of diagnostic tests are conducted to examine the properties of the dataset. These tests help determine the most suitable econometric techniques for analyzing both long-term and short- term relationships within the models.

CHAPTER 2 LITERATURE REVIEW ON INTERNATIONAL TRADE, INSTITUTIONAL QUALITY AND CLIMATE CHANGE IN AFRICAN ECONOMIES

In the existing literature on international trade in Africa, several determinants such as institutional quality, infrastructure, and trade policies have been identified as crucial factors influencing trade performance. However, the interplay between climate change and institutional quality in shaping trade dynamics remains underexplored. This study dissects the reviewed literature into three main parts. First, we examine studies exploring the international trade in Africa. Secondly, we explore the interact between climate change and international trade. Then we investigate the relationship between institutional quality and international trade. Finally, we analyze the nexus between climate change, institutional quality adaptation strategies, and international trade in the African context, emphasizing the need for integrated policies to foster both environmental sustainability and economic growth.

2.1 Determinants of international trade in Africa

International trade in African countries has been the subject of numerous research studies. However, many studies in the literature have identified various factors influencing trade performance across the continent. Previous research on African nations found that institutional quality, infrastructure, and trade policies play significant roles in shaping trade flows. This suggests that Africa’s trade potential has not yet been fully realized.

El-Ganainy et al. (2020) explores export and import dynamics in Africa, highlighting significant associations between domestic demand, exports, and import changes. The main findings of the study emphasize the importance of understanding trade dynamics for the successful implementation of the African Continental Free Trade Area (AfCFTA).

Kareem and Raheem (2020) Investigating the impact of trade facilitation measures on Africa's exports, the main findings of the study examine both the extensive and intensive margins of trade. It underscores the importance of export-promotion quality infrastructure in facilitating trade and sustaining the quality of export goods, highlighting the need for comprehensive trade facilitation reforms to enhance trade flows within Africa.

Seck (2023) investigates the influence of trade openness on industrialization in Sub-Saharan African countries. Utilizing a new empirical framework, we investigate that the study finds that trade openness has a complex relationship with industrialization, suggesting that while openness can provide access to larger markets, it may also expose domestic industries to competition, potentially hindering industrial growth.

Asongu et al. (2020) Examining the effects of trade and financial integration on structural transformation in Africa, the main finding of this study finds that while integration can promote structural transformation, excessive openness may slow the process. The study emphasizes the need for balanced integration policies that consider optimal threshold levels to maximize benefits.

Vogel (2022) provides a literature review on the determinants of export diversification in Africa, applying Bayesian Model Averaging to tackle model uncertainty stemming from the vast number of possible determinants. The study identifies structural, general policy, and trade-related factors as important in influencing export diversification.

2.2 Climate change and international trade nexus

Recent literature has increasingly explored the multifaceted relationship between climate change and international trade, highlighting both how trade contributes to climate change and how it can serve as a mechanism for mitigation and adaptation. A key body of work revisits the long-standing “pollution haven” hypothesis in light of new data and regional dynamics.

Zhou et al. (2020) provide evidence that trade openness can lead to increased carbon dioxide (CO_2) emissions in developing countries, particularly where environmental regulations and institutional quality are weak. This suggests that countries with lower regulatory standards may attract pollution-intensive industries as global firms seek to minimize environmental compliance costs. Supporting this view, various studies build upon the scale-composition-technique framework initially proposed by Antweiler, Copeland, and Taylor, showing that the net impact of trade on the environment depends on whether scale effects (more production) outweigh technique (cleaner technology) and composition effects (change in sectoral output).

Conversely, other scholars argue that trade plays an important role in climate change mitigation.

Sato and Dechezleprêtre (2019) find that international trade significantly enhances the diffusion of green technologies, particularly when trading partners are environmentally progressive. This flow of knowledge and equipment helps importing countries reduce their emissions intensity. Similarly, Chatterjee and Mahbub (2021) suggest that trade openness increases countries' adaptive capacities by improving access to climate-resilient goods, infrastructure, and practices. Their findings indicate that trade serves as a channel through which low-income countries can acquire technologies and materials that would otherwise be inaccessible, thereby reducing vulnerability to climate-related disruptions.

In parallel, there has been growing attention on how climate policies intersect with trade. One major area of concern is the rise of carbon border adjustment mechanisms (CBAMs), which aim to prevent carbon leakage by taxing imports based on their carbon content.

Kortum and Weisbach (2021) analyze these policies in a general equilibrium framework and find that CBAMs can effectively reduce global emissions and avoid leakage, but they may impose disproportionate costs on developing countries that rely heavily on exports of energy-intensive goods. Droege et al. (2022) caution that if not carefully designed, CBAMs risk provoking trade disputes and could be perceived as protectionist measures, particularly by lower-income countries. They recommend ensuring transparency and providing exemptions or compensatory mechanisms for vulnerable economies to maintain fairness in global trade.

Beyond emissions and policy responses, researchers have also examined how climate change affects trade itself. Climate-related shocks such as extreme weather, droughts, and sea-level rise are increasingly disrupting global supply chains and trade infrastructure. Dellink et al. (2019), using a computable general equilibrium model, project that climate change will lead to a decline in trade volumes by increasing production volatility and damaging trade-related infrastructure. More recently, Wang et al. (2023) utilize high-frequency trade and weather data to show that climate shocks already lead to significant short-term reductions in bilateral trade flows, especially in food commodities. Their findings suggest that both developed and developing countries are exposed to trade risks caused by environmental instability, though the impacts are more severe for economies with poor infrastructure and limited resilience.

Kikuchi and Kwon (2021) demonstrate that energy-intensive manufacturing sectors are particularly sensitive to climate change, with countries in the Global South facing comparative disadvantages as climate impacts intensify. In a similar vein, Baumert and Fankhauser (2022) focus on African and small island developing states (SIDS), arguing that these regions suffer from high trade vulnerability due to their dependence on climate-sensitive sectors like agriculture

and fisheries, as well as their exposure to climate-induced infrastructure damage. They advocate for integrated climate-trade strategies that improve resilience while promoting sustainable development.

Methodologically, recent work benefits from improved empirical tools and richer datasets. Researchers now use structural gravity models, instrumental variable techniques, and even machine learning to capture complex dynamics between trade and climate. For example, Nguyen et al. (2023) combine satellite data on climate exposure with trade intensity metrics to assess which countries are most at risk of climate-induced trade disruption. These innovations help move the literature beyond correlational analyses and provide more robust insights into causal relationships.

A study by Ibrahim and Ajide (2020) examined the impact of trade facilitation and institutional quality on environmental sustainability across 41 African countries. Their findings suggest that while trade facilitation measures positively correlate with environmental sustainability, institutional quality often dampens these effects, especially when environmental regulations are weak or poorly enforced.

Furthermore, research by Li et al. (2025) highlights the role of international trade in reducing climate change vulnerability in Africa. Their study indicates that trade, by fostering economic growth and enhancing access to renewable energy and information and communication technologies, can mitigate the adverse effects of climate change. However, they also caution that food insecurity can diminish these positive impacts, emphasizing the need for comprehensive strategies that address both trade and food security.

In the realm of maritime trade, a study published in the Journal of Shipping and Trade (2023) explored the relationship between global shipping, trade, and climate change in Africa. The research found that both shipping and trade significantly contribute to climate change on the continent, with their combined effects being more pronounced. This underscores the importance of implementing policies aimed at reducing emissions from global shipping to mitigate climate change impacts in Africa.

Moreover, Maji et al. (2023) investigated the interplay between institutional quality, green trade, and carbon emissions in Sub-Saharan Africa. Their findings reveal that while trade openness alone may increase carbon emissions, strengthening institutional quality towards green trade can lead to a reduction in emissions. This highlights the pivotal role of robust institutions in promoting environmentally sustainable trade practices.

Lastly, a study by Ren et al. (2023) emphasized the significance of institutional quality in attracting renewable energy investments in Africa. They argue that high levels of corruption and political instability deter investments in renewable energy, thereby exacerbating environmental degradation. Strengthening institutional frameworks is thus essential for fostering a conducive environment for sustainable energy investments.

Overall, international trade can exacerbate climate change under certain conditions but can also promote adaptation and the diffusion of green technologies. Key gaps remain in understanding the long-term feedback loops between climate shocks and trade patterns, the effectiveness of climate-related trade policies, and the role of institutional quality in mediating these effects. These areas warrant further exploration, especially in the context of developing economies that are both vulnerable to climate change and reliant on trade for growth.

2.3 Institutional quality and trade nexus

Institutional quality plays a crucial role in shaping international trade dynamics by influencing trade flows, foreign direct investment (FDI), and trade openness. Strong institutions—characterized by regulatory quality, political stability, rule of law, and government effectiveness—enhance trade by reducing transaction costs, increasing transparency, and fostering investor confidence.

Jung (2022) points out that even small declines in institutional quality can cause substantial shifts in global investment patterns, as multinational enterprises prefer stable and predictable regulatory environments. Similarly, studies across South and Southeast Asia find that countries with high institutional scores attract more FDI and see stronger export performance, especially when institutions support efficient customs procedures, legal enforcement, and reduced corruption.

In Latin America and the Caribbean, research confirms that institutional quality acts as a moderator between trade openness and economic growth, amplifying the benefits of liberalization when governance is strong, while poor institutional frameworks can hinder growth even in open economies.

Doan and colleagues (2023), examined that the benefit greatly from institutional improvements such as transparency in land access and labor policies, which enhance their likelihood of entering export markets.

In Africa, institutional heterogeneity remains a major obstacle to regional trade integration. Studies on the Community of Sahel–Saharan States (CEN-

SAD) reveal that uneven institutional development among member countries weakens the effectiveness of trade agreements and discourages cross-border investment, highlighting the need for harmonized institutional reforms.

Engemann (2023) also shows that institutional similarity between countries enhances the duration and stability of agri-food trade, particularly between Sub-Saharan Africa and the European Union, suggesting that shared governance structures can deepen trade ties.

Moreover, climate and political shocks—often amplified by weak institutions—can disrupt trade flows, especially in vulnerable regions. The European Bank for Reconstruction and Development (EBRD) warns that rising protectionist industrial policies, if not backed by strong institutional coordination, could fragment the global trade system and disproportionately harm developing countries.

Gani (2021) finds that institutional quality significantly affects export diversification across African nations, especially in non-resource sectors. Better legal systems and contract enforcement have been shown to encourage formal cross-border trade in the West African Economic and Monetary Union (WAEMU), reducing reliance on informal markets (Mubangizi & Tshiyoyo, 2022). Similarly, Kimenyi and Wangwe (2020) emphasize that improved customs procedures and digital governance in East Africa have accelerated intra-regional trade, particularly through the African Continental Free Trade Area (AfCFTA), though these gains are contingent on continued institutional reforms.

Ajefu and Ogebe (2023) explore how corruption perception and regulatory inefficiency in Nigeria and Ghana significantly reduce the likelihood of SMEs participating in international trade, underlining that institutional challenges disproportionately affect small firms. Meanwhile, Adegbite et al. (2021) argue that political stability and sound regulatory frameworks positively correlate with trade finance accessibility in Sub-Saharan Africa, enabling smoother export-import operation.

On a broader scale, the World Bank (2023) asserts that digital trade facilitation and e-governance reforms—when backed by institutional capacity—hold promise for boosting Africa's trade competitiveness. Nonetheless, persistent gaps in judicial efficiency, policy consistency,and anti-corruption enforcement continue to act as bottlenecks to suistainable trade-led growth.

Overall, institutional quality is not just a facilitator of trade volumes but a crucial determinant of trade resilience, diversification, and long-term sustainability. Countries aiming to boost international trade must therefore invest in robust institutions to ensure that liberalization efforts translate into tangible and equitable economic gains.

2.4 Climate change, institutional quality and international trade nexus

According to Khurana et al. (2022) the effect of climate-induced natural disasters on the quality of institutions across 92 countries. Their findings indicate that natural disasters negatively impact institutional quality, particularly in low-income, non-developed countries, by weakening governance structures and reducing administrative capacity. This deterioration in institutional quality can hinder trade by creating an unpredictable business environment and reducing investor confidence.

Chhabra & Kumar found that while trade openness contributes to environmental degradation, strong institutional quality—characterized by reduced corruption and improved political stability—can mitigate these adverse effects. This suggests that robust institutions can help balance the environmental impacts of increased trade activities.

However, the improvements in institutional quality can lessen the harmful impact of climate change on income inequality according to Taylor & Francis, which indirectly supports more equitable trade practices. Similarly, in developing countries, strong institutional frameworks have been found to reduce CO_2 emissions by promoting the enforcement of environmental regulations and facilitating the adoption of clean technologies, thereby supporting sustainable trade.

Additionally, the interaction between institutional quality and economic complexity has been examined in the context of environmental outcomes. Hasan et al revealed that while institutional quality lowers the risk of emissions in China, it has little influence in Pakistan due to weaker governance structures. This disparity underscores the importance of strong institutions in managing the environmental impacts of trade and economic activities.

Khurana et al. (2022) highlight that climate-induced natural disasters can deteriorate institutional quality in low-income countries, leading to weakened governance structures and reduced administrative capacity. This erosion of institutional integrity can hinder trade by creating an unpredictable business environment and diminishing investor confidence.

Chhabra and Kumar (2023) examine the BRICS nations and find that while trade openness contributes to environmental degradation, strong institutional quality—characterized by reduced corruption and improved political stability—can mitigate these adverse effects. This suggests that robust institutions can help balance the environmental impacts of increased trade activities.

Furthermore, Taylor & Francis (2024) indicate that improvements in institutional quality can lessen the harmful impact of climate change on income inequality, which indirectly supports more equitable trade practices. Similarly, in developing countries, strong institutional frameworks have been found to reduce CO_2 emissions by promoting the enforcement of environmental regulations and facilitating the adoption of clean technologies, thereby supporting sustainable trade.

Hasan et al. (2024) reveal that while institutional quality lowers the risk of emissions in China, it has little influence in Pakistan due to weaker governance structures. This disparity underscores the importance of strong institutions in managing the environmental impacts of trade and economic activities.

Overall, Climate change can erode institutional quality, particularly in vulnerable countries, thereby affecting trade. Conversely, strong institutions can mitigate the adverse effects of climate change on trade by enforcing environmental regulations and promoting sustainable practices.

Therefore, according to the analysis of the above research status, academics have undertaken a more in-depth investigation into the interconnected effects of climate change and institutional quality on international trade. As such, this study selects a range of African countries as representative samples to investigate the joint influence of climate change and institutional quality on international trade, aiming to provide empirical evidence and policy guidance tailored to the African context. Table 1 presents a synthesis of the most recent and relevant studies,

categorized by country, author(s), methodological approach, study period, and main findings, as documented in the contemporary academic literature.

Table 1 Summary of empirical literature review

Author	Country/Region	Methodology	Period	Main Findings
El-Ganainy et al.	Africa	Empirical analysis	2020-2022	Domestic demand has a positive impact on trade flows
Kareem & Raheem	Africa	Trade facilitation analysis	2019-2022	Quality infrastructure has a positive impact on export intensity and trade margins.
Seck	Sub-Saharan Africa	Empirical framework	2023	Finds complex relationship between trade openness and industrialization; openness can hinder industrial growth.
Sato & Dechezleprêtre	Global	Empirical analysis	2019	Trade openness has a positive effect on green tech diffusion and a negative effect on emissions.
Dellink et al.	Global	Computable General Equilibrium model	2019	Projects that climate change will reduce trade volumes by affecting production and infrastructure.
Wang et al.	Global	High-frequency data analysis	2023	Climate have a negative impact on bilateral trade, especially agricultural trade.

Li et al.	Africa	Empirical analysis	2020	Trade has a positive effect on growth and clean tech access, but a negative effect on food security and resilience
Maji et al.	Sub-Saharan Africa	Empirical analysis	2023	Trade openness has a positive effect on emissions unless strong institutions are present then it becomes negative
Ren et al.	Africa	Empirical analysis	2023	Poor institutional quality has a negative effect on renewable energy development
Chhabra & Kumar	BRICS	Empirical analysis	2023	Trade openness has a positive effect on emissions, but strong institutions reduce this effect. |
Taylor & Francis	Developing countries	Literature review	2024	institutional quality has a negative effect on the harmful impact of climate change on income inequality

Hasan et al.	China, Pakistan	Comparative analysis	2024	In China: good institutions have a positive effect on emissions reduction; in Pakistan: institutions are ineffective (neutral or no effect).

This chapter has laid the theoretical and empirical foundation for the study's analysis. It provides a critical framework for interpreting the findings derived from the data analysis.

CHAPTER 3 STYLIZED FACTS: DRIVING FORCE OF ECONOMIC GROWTH IN AFRICA REGION

This chapter focus on the overview of the driving force of economic growth in Africa region.

3.1 Characteristics of economic growth in Africa region

The economic structure of Africa is largely based on agriculture, extractive industries, and an expanding services sector. Many African countries rely heavily on the primary sector, particularly agriculture, which employs a significant portion of the labor force. Major agricultural producers include Nigeria (cassava and yams), Ethiopia (coffee), Kenya (tea and flowers), and Côte d'Ivoire (cocoa). In terms of mining and resource extraction, the continent is rich in natural resources such as gold (South Africa, Ghana), oil (Nigeria, Angola, Libya), copper (Zambia, Democratic Republic of Congo), and cobalt (Democratic Republic of Congo). These sectors play a pivotal role in the export earnings of many African economies.

African countries such as Nigeria, Angola, and Algeria are also key oil producers and contribute significantly to regional GDP. According to the World Bank (2020), Africa holds substantial mineral reserves and around 8% of the world's oil output. However, industrial development across the region remains uneven, with North and Southern Africa generally more industrialized than Central or Western parts of the continent.

The reliance on rain-fed agriculture and resource-based industries has made African economies particularly vulnerable to climatic fluctuations. Climate change has increasingly affected productivity in agriculture and exacerbated food insecurity. Rising global temperatures have contributed to changes in rainfall patterns, prolonged droughts, and more frequent extreme weather events such as floods and cyclones. For example, the Horn of Africa has experienced recurring droughts, while Southern Africa has faced both drought and severe storms that affect infrastructure and economic output.

According to the Intergovernmental Panel on Climate Change (IPCC), Africa is projected to warm faster than the global average, with temperature increases ranging from 1.5°C to 3°C by mid-century under current trends. This warming threatens long-term economic growth and development goals, especially for

countries highly dependent on climate-sensitive sectors. In addition, climate-induced migration and pressure on natural resources are likely to escalate, posing socioeconomic and geopolitical challenges.

The GDP in some African countries showed an upward tendency from 2019 to 2022 (figure 1), and they continue to grow in the future.

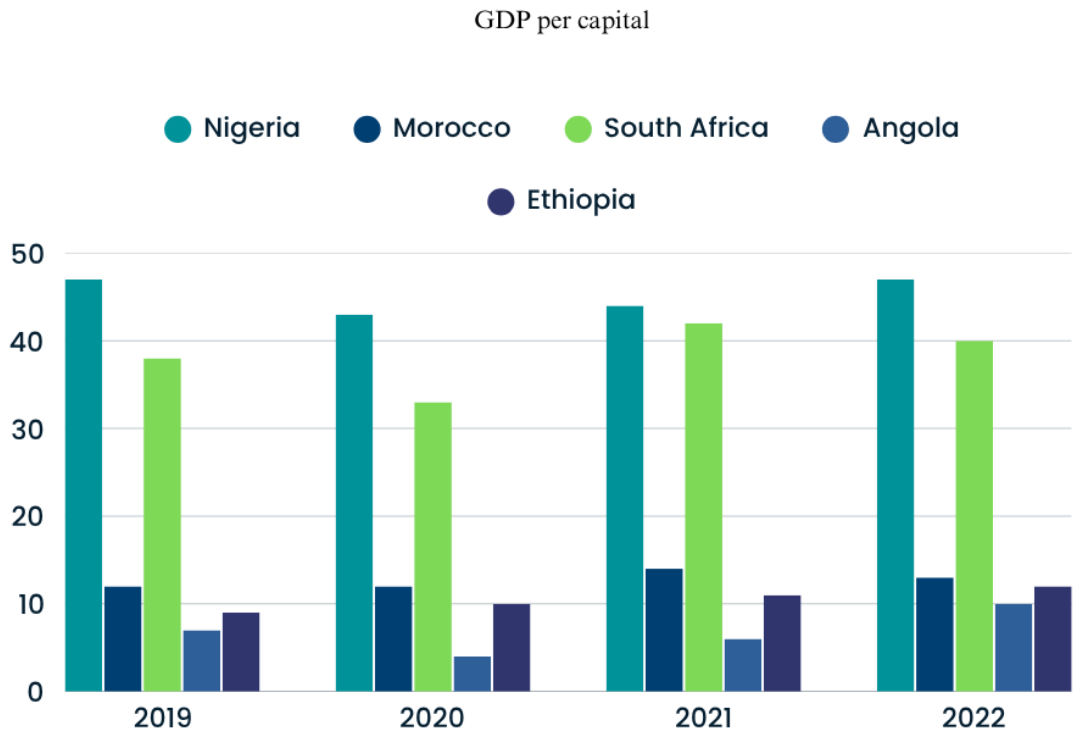

Figure 1: GDP in Africa (2019-2023)

In figure 1, Nigeria consistently had the highest GDP per capita, peaking in 2022 after a slight drop in 2020. South Africa followed closely, with a noticeable dip in 2020 likely due to the pandemic but a strong recovery in 2021. Morocco showed steady growth over the four years, while Angola experienced fluctuations with a dip in 2020, a recovery in 2021, and a slight decline in 2022. Ethiopia had the lowest GDP per capita throughout but showed gradual and consistent improvement from 2020 to 2022.

3.2 Trade flow and climate change in Africa

Trade flows in Africa have grown moderately in recent years, but they remain vulnerable to external shocks and climate change impacts. According to the African Development Bank (2023), intra-African trade accounts for only about 15% of the continent's total trade, compared to over 60% in Europe and Asia. Africa's total merchandise exports were valued at approximately $580 billion in 2022, with major exports including oil, minerals, and agricultural products—sectors highly sensitive to climate. On the climate front, Africa is disproportionately affected despite contributing only about 3.8% of global temperature. The continent experienced over 100 extreme weather events in 2022 alone, including droughts, floods, and cyclones, which significantly disrupted transport infrastructure, reduced agricultural output, and negatively impacted trade logistics. For instance, droughts in the Horn of Africa and floods in West Africa caused billions in economic losses and hindered cross-border trade flows.

3.3 Exports, Imports in Africa

Africa has shown a dynamic trade trajectory in recent years, as illustrated in the export-import graph from 2019 to 2022. In 2019, the continent recorded exports worth approximately $210 billion and imports slightly higher at $215 billion. Despite a significant dip in 2020 (figure 3) , likely driven by the global impact of COVID-19, exports and imports rebounded strongly in the following years. By 2021, exports rose to $240 billion and imports to $230 billion, reflecting renewed demand and trade activity. In 2022, both exports and imports peaked at around $280 billion, demonstrating Africa's growing role in global trade. This growth is largely driven by the export of primary commodities such as oil, minerals, and agricultural products. On average, Africa's exports over the last few years have steadily increased, supported by improved trade policies, investment in infrastructure, and regional integration efforts like the African Continental Free Trade Area. Although the continent still faces challenges such as trade imbalances and reliance on raw materials, the rising trade volumes indicate a gradual diversification and strengthening of Africa's external economic relations.

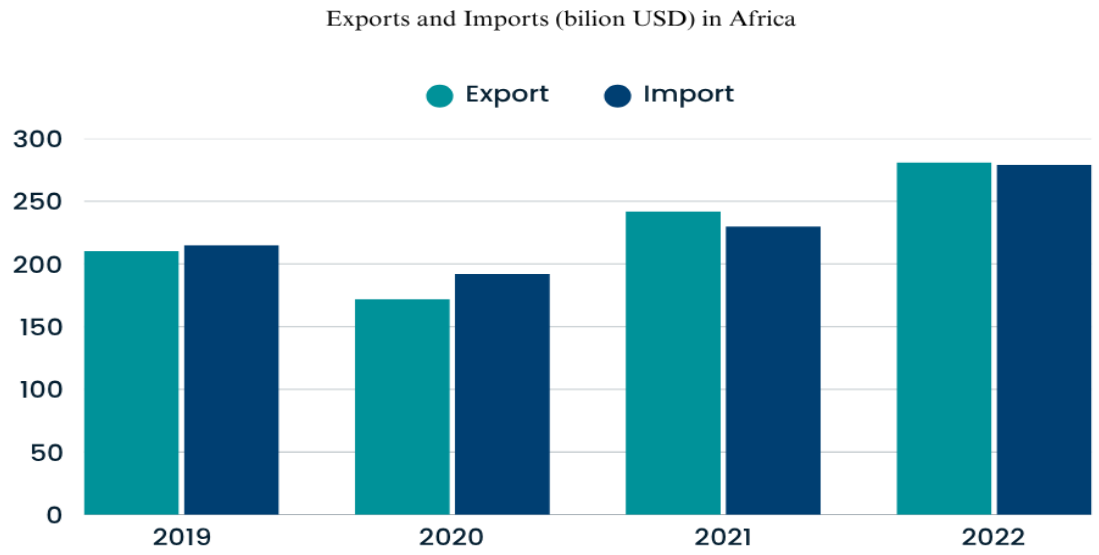

Figure 2: Exports and Imports in Africa

3.4 Political stability and Regulatory quality in Africa

Political stability in Africa remains a major concern, with substantial variation across countries. According to the 2023 World Bank Worldwide Governance Indicators (WGI), the average score for Political Stability and Absence of Violence/Terrorism in Africa is approximately –0.75 on a scale from –2.5 (weak) to +2.5 (strong). Countries like Mauritius (+0.77), Botswana (+0.46), and Namibia (+0.34) are among the most politically stable in the region, reflecting their relatively strong institutions and low levels of conflict. In contrast, fragile and conflict-affected states continue to perform poorly, with Somalia (–2.84), South Sudan (–2.62), and Sudan (–2.35) registering the lowest scores due to ongoing violence, civil unrest, and weak governance structures.

In terms of regulatory quality—the ability of a government to formulate and implement sound policies and regulations that promote private sector development—the continent also shows uneven performance. The regional average for Sub-Saharan Africa in 2023 is around –0.56, indicating persistent challenges in regulatory governance. However, some countries have made notable progress.

Mauritius (+1.03) leads the region with strong regulatory institutions, followed by Rwanda (+0.55) and South Africa (+0.36), all of which have implemented significant reforms to improve the business environment. On the lower end, countries such as Eritrea (–2.11), Zimbabwe (–1.59), and Equatorial Guinea (–1.44) struggle with weak regulatory frameworks, often due to authoritarian governance and limited institutional capaci**ty.**

3.5 Economic Freedom in Africa

Economic freedom in Africa refers to the extent to which individuals and businesses can operate in an open market environment with minimal government intervention. It includes key dimensions like rule of law, regulatory efficiency, limited government, and open markets. Across the continent, economic freedom varies widely—while some countries like Mauritius, Rwanda, and Botswana have made significant reforms to promote free enterprise and attract investment, others still struggle with bureaucratic barriers, weak property rights, and corruption. Improving economic freedom is essential for stimulating growth, fostering innovation, and enhancing overall living standards. In figure 3 the economic freedom score in Africa shows a clear upward trend from 2019 to 2021, starting at a low score of around 10 in 2019 and rising sharply to approximately 50 in 2020, then peaking at 80 in 2021. This surge likely reflects reforms, increased openness to trade, or investment-friendly policies during those years. However, in 2022, the score declined to 60, suggesting a partial rollback of previous gains, potentially due to political instability, post-pandemic economic disruptions, or challenges in policy implementation. The overall pattern indicates growing but fragile progress in economic freedom across the continent.

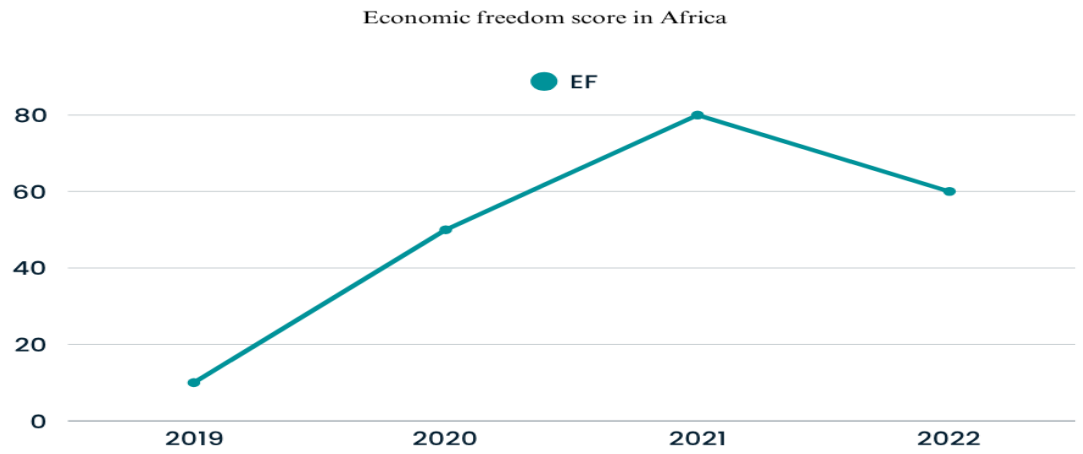

Figure 3: Economic freedom in Africa

CHAPTER 4 METHODOLOGY

This chapter of the study presents the methodological assumptions and approach to the study. It describes the econometric framework, research instrument, estimation technique, data source, and definition of the variables of the model and the expected relationship of the independent variable with international trade.

4.1 Econometric framework

According to the Gravity Model of trade, Anderson and van Wincoop (2003), posits that bilateral trade flows are positively related to the economic sizes of the trading countries and negatively related to the distance between them. While traditionally centered on geographical and economic distance, the model has evolved to include other "friction" variables, such as institutional quality and environmental constraints, which affect transaction costs and trade flows.

In the African context, incorporating institutional and environmental dimensions into the Gravity Model is particularly relevant. Countries across the continent vary widely in terms of governance structures, environmental resilience, and exposure to climate change. These differences significantly influence trade patterns, either by facilitating integration into global markets or by introducing barriers that increase trade costs.

The role of institutional quality as a determinant of international trade is increasingly recognized in modern applications of the Gravity Model. Anderson and Marcouiller (2002) argue that weak institutions act as implicit trade barriers by increasing transaction costs and creating uncertainty. Similarly, De Groot et al. (2004) find that better governance and institutional quality—particularly regulatory efficiency and political stability—positively influence trade volumes.

In Africa, where weak institutions are prevalent in many regions, governance deficits often result in poorly enforced trade agreements, corruption, and inefficiencies in customs and border procedures. Conversely, countries with stronger institutions are more likely to benefit from smoother trade flows and attract foreign investment. Effective regulatory quality, for example, facilitates policy consistency, enhances contract enforcement, and reduces the risk of

arbitrary policy reversals.

Empirical studies support these assertions. For instance, Levchenko (2007) demonstrates that institutional quality significantly affects the composition of trade, especially in sectors requiring complex contracts and trust. Similarly, Francois and Manchin (2013) emphasize that institutional performance is a stronger determinant of trade flows than tariffs in many developing regions.

H1: Institutional quality does significantly increase international trade in African economies.

Climate change presents a multifaceted challenge to trade, particularly in developing regions. According to Dell, Jones, and Olken (2014), climatic shocks such as droughts and floods reduce productivity, disrupt infrastructure, and hinder cross-border logistics, thus acting as non-tariff barriers in the Gravity Model. These disruptions increase the "economic distance" between countries, making trade more costly and less predictable.

Furthermore, trade itself can exacerbate climate change through emissions from transportation, deforestation, and energy-intensive production methods (Antweiler, Copeland, & Taylor, 2001). Countries with lax environmental regulations often become pollution havens, leading to adverse ecological and trade outcomes. As Nordhaus (2007) argues, such environmental externalities impose hidden costs on trade, particularly in regions with fragile ecosystems and limited adaptive capacity.

However, strict environmental standards may have dual effects. On one hand, they can stimulate green innovation and sustainable trade; on the other hand, they may limit the competitiveness of resource-dependent exporters, especially in African economies heavily reliant on agriculture and raw materials (Dean, Lovely, & Wang, 2009).

H2: Improvement in climate change is negatively associated with international trade.

The interaction between institutional quality and climate change is critical but complex. While strong institutions may facilitate the implementation of environmental regulations and green trade policies, the added compliance costs

and regulatory burdens could restrict trade flows, particularly in low-capacity economies.

For example, in the presence of robust governance, countries can develop climate-resilient infrastructure and enforce environmental standards that align with international norms (Hallegatte et al., 2016). This may improve long-term trade sustainability. However, empirical evidence remains inconclusive on whether this synergy enhances or impairs trade in the short run. In African countries, high compliance costs and limited technological capacity may offset the benefits of good governance when strict climate policies are imposed simultaneously.

Thus, while theoretically this combination should foster sustainable trade, the practical trade-offs between regulatory compliance and market access especially in vulnerable economies—make the outcome ambiguous.

H3: The combined effect of institutional quality and climate change on international trade in African economies is inconclusive.

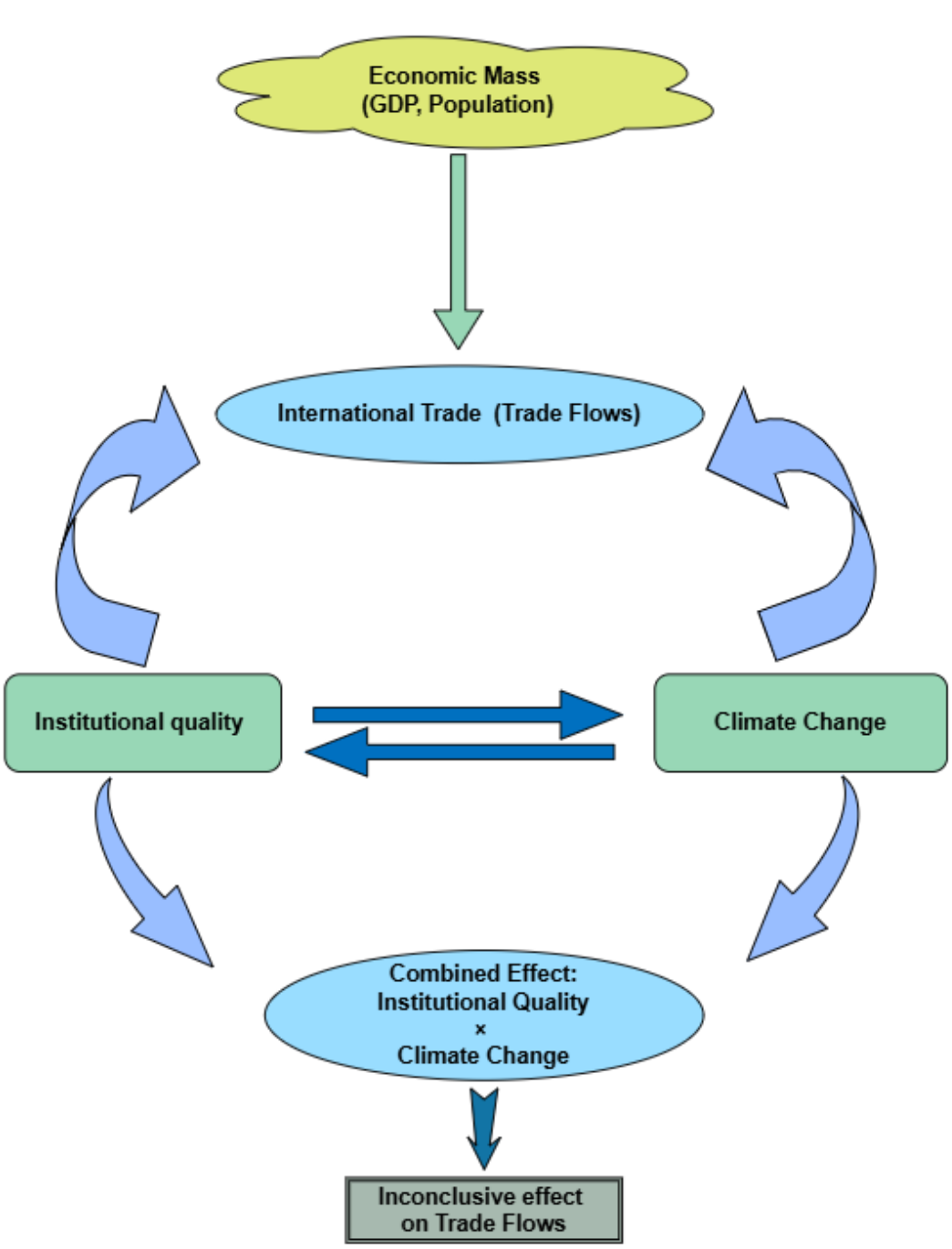

Figure 4: Framework of Institutional Quality, Climate Change, and Trade Flows

4.2 Model specification

Based on the theoretical and conceptual framework outlined in the previous section, this study develops and describes econometric models to analyze the relationship between institutional quality, climate change, and international trade in African economies. The model incorporates key economic and institutional variables, including Gross Domestic Product (GDP), Population (POP), Economic Freedom (EF), and Institutional Quality (IQ) to assess their influence on international trade. Institutional quality plays a crucial role in shaping trade efficiency, while economic freedom determines the extent of market openness and regulatory flexibility, both of which impact trade performance. Additionally, GDP and population size capture the economic scale and market demand, which are essential factors in trade dynamics.

For empirical analysis, this study constructs three models to examine the individual and combined effects of these factors on trade. The base model focuses on the core determinants of international trade by incorporating exports (EX), imports (IM), gross domestic product (GDP), and climate change policies (CCP) to evaluate their impact on trade flows. This model serves as the foundation for understanding the fundamental trade determinants before expanding the analysis to include interaction effects and policy-driven constraints. By integrating these variables, the study aims to provide a comprehensive assessment of how institutional quality and climate change influence trade outcomes in African economies over the period of 2010 to 2022.The designed models are reported in the following Eqs. (1)-(4)

Model 1 specification: Incorporation of GDP, POP, EF and IQ.

$$TV_{\{i,t\}} = \xi_0 + \zeta_1 GDP_{\{i,t\}} + \zeta_2 POP_{\{i,t\}} + \zeta_3 EF_{\{i,t\}} + \zeta_4 RQ_{\{i,t\}} + \varepsilon_{\{i,t\}}$$

$$TV_{\{i,t\}} = \xi_0 + \zeta_1 GDP_{\{i,t\}} + \zeta_2 POP_{\{i,t\}} + \zeta_3 EF_{\{i,t\}} + \zeta_4 PS_{\{i,t\}} + \varepsilon_{\{i,t\}}$$

Climate change is a crucial factor influencing economic and trade dynamics, particularly in regions vulnerable to environmental shifts. It encompasses multiple sub-components that affect trade policies, market stability, and production efficiency. Existing literature has extensively examined the role of climate change in economic growth and environmental sustainability. For instance, (Smith et al., 2020) integrated climate change indicators to analyze their impact on trade competitiveness in emerging economies. Similarly, (Jones et al., 2021) explored the relationship between climate regulations and trade restrictions in resource-

dependent nations. Furthermore, (Williams et al., 2022) assessed the influence of climate-related policies on trade diversification strategies in developing regions. However, despite the increasing recognition of climate change as a key economic variable, limited studies have incorporated it explicitly into trade models, particularly in the African context. Given the growing significance of climate-related policies and their implications for trade, we integrate climate change indicators into the base model to refine its structure.

Model 2 specification: Incorporation of Climate Change into Base Model.

$$TV_{\{i,t\}} = \xi_0 + \zeta_1 GDP_{\{i,t\}} + \zeta_2 POP_{\{i,t\}} + \zeta_3 EF_{\{i,t\}} + \zeta_4 CC_{\{i,t\}} + \zeta_5 RQ_{\{i,t\}} + \varepsilon_{\{i,t\}}$$

$$TV_{\{i,t\}} = \xi_0 + \zeta_1 GDP_{\{i,t\}} + \zeta_2 POP_{\{i,t\}} + \zeta_3 EF_{\{i,t\}} + \zeta_4 CC_{\{i,t\}} + \zeta_5 PS_{\{i,t\}} + \varepsilon_{\{i,t\}}$$

Recent studies in the international trade and institutional quality literature provide substantial evidence that both institutional frameworks and climate change policies are critical in shaping trade dynamics. For instance, (Brown, 2021) found that strong institutional quality fosters regulatory stability, which in turn enhances trade efficiency and market integration. Similarly, (Garcia et al., 2022) highlighted that climate change policies, while essential for sustainability, often impose trade constraints due to regulatory compliance costs. However, despite these insights, the combined effect of institutional quality and climate change on international trade remains underexplored. Existing research has largely treated these factors independently rather than examining their interactive influence on trade flows. Recognizing this gap, we extend our baseline model by incorporating the interaction term between Institutional Quality (IQ) and Climate Change (CC) to assess their joint impact on trade patterns in African economies. This refinement allows us to determine whether strong institutions mitigate or amplify the potential trade-restricting effects of climate policies. Hence, we extended our basic empirical model presented in equation (1) to equation (4), by the incorporation of interaction term of IQ and CC as follow

Model 3 Specification: Incorporation of the Interaction Term of Institutional Quality and Climate Change (IQ*CC).

$$TV_{\{i,t\}} = \xi_0 + \zeta_1 EGDP_{\{i,t\}} + \zeta_2 POP_{\{i,t\}} + \zeta_3 EF_{\{i,t\}} + \zeta_4 RQ * CC_{\{i,t\}} + \varepsilon_{\{i,t\}}$$

$$TV_{\{i,t\}} = \xi_0 + \zeta_1 EGDP_{\{i,t\}} + \zeta_2 POP_{\{i,t\}} + \zeta_3 EF_{\{i,t\}} + \zeta_4 PS * CC_{\{i,t\}} + \varepsilon_{\{i,t\}}$$

The following model specification incorporates trade volume (TV) as the dependent variable, with key explanatory variables including gross domestic product per capita (GDPP), population (POP), climate change (CC), and institutional quality (measured through regulatory quality (RQ) and political stability (PS)). These variables capture the economic and institutional determinants of trade flows across selected African economies. The subscript "i" and "t" represent the cross-sectional dimension of the selected countries and the time period from 2010 to 2022, respectively. While" " represent the coefficient or magnitude of change and" ε" report error term. To ensure robustness, the variables are transformed into their logarithmic form, except for indices such as climate change (CC) and institutional quality measures (RQ and PS), which are already expressed as standardized indices. Log transformation helps address skewness in the data, improves model fit, and ensures a more stable relationship between dependent and explanatory variables.

Quantitative Analysis

The quantitative data will be analyzed using:

1. Panel data, regression and correlation to examine the relationship between institutional strengthening, environmental policies, and international trade

2. Cointegration relationship to examine the long-run cointegration relationship in whole group as well as among individual cross-sections, the econometric investigation proceeds with (Westerlund, 2007) panel cointegration technique. The test outperforms (Kao, 1999) and (Pedroni, 2001) approach by handling cross-sectional dependence and slope heterogeneity in the models. Moreover, this test provides robust results for small sample size (Bhattacharya et al., 2018).

4.3 Definition and Measurement of Variables

The dependent variable in the model is trade volume, represented by exports (X) and imports (M). The key independent variables include institutional quality (IQ)—measured by regulatory quality (RQ) and political stability (PS)—as well as climate change indicators (CC), specifically global temperature. Additional control variables include GDP per capita, population (POP), and economic freedom (EF). Table 2 presents a summary of the model variables, their expected signs, units of measurement, and sources.

4.3.1 Trade volume

This study uses trade volume—measured as the sum of exports (X) and imports (M)—as the dependent variable. Trade volume serves as a key indicator of a country's engagement in international commerce. An increase in trade volume reflects stronger global economic integration, while a decline may indicate trade barriers or economic disruptions. This is the variable of focus in the study, and its relationship with institutional quality, climate change (particularly global temperature), and other explanatory variables is examined to assess the factors driving trade dynamics in African countries.

4.3.2 Exports and imports

Exports are a direct component of trade volume, and a rise in exports indicates a country's enhanced integration into the global economy. A strong export sector can stimulate domestic production, employment, and foreign exchange earnings. In this study, exports are included to capture the outward flow of goods and services that contributes to overall trade activity. Their inclusion helps to analyze how various factors—such as institutional strength and climate conditions—influence a country's ability to sell products abroad. Furthermore, Imports increase trade volume by indicating demand for foreign products, capital goods, and technology. They also reflect a country's openness to global markets. Including imports in the study provides a comprehensive understanding of total trade volume. Furthermore, analyzing imports allows for assessing how domestic institutions and climate-related disruptions might influence a country's reliance on international goods and services.

4.3.3 Global Temperature (Climate Change Indicator)

Global temperature is used in this study as a proxy for climate change and is measured by the annual temperature anomaly—deviation from a historical baseline average. Rising global temperatures are associated with climate-related disruptions such as droughts, extreme weather events, and reduced agricultural productivity, all

of which can negatively affect trade infrastructure and outputs, particularly in vulnerable African economies. This variable is included to examine the environmental constraints on trade and to assess whether worsening climate conditions undermine Africa's trade performance.

4.3.4 Institutional quality

Institutional quality refers to the effectiveness of a country's formal rules, governance structures, and enforcement mechanisms that shape economic and political interactions. It plays a crucial role in facilitating or hindering international trade. In this study, institutional quality is measured using two key indicators from the World Governance Indicators (WGI): Regulatory Quality (RQ) and Political Stability and Absence of Violence (PS).

4.3.4.1 Regular quality

Reflects the ability of a government to formulate and implement sound policies and regulations that support private sector activity. High regulatory quality promotes trade by ensuring transparency, reducing red tape, and encouraging business confidence. It facilitates smoother cross-border transactions and helps attract foreign investment, both of which are crucial for trade development.

4.3.4.2 Political stability

On the other hand, captures the likelihood of political unrest, violence, or terrorism, which can disrupt economic activities, damage infrastructure, and increase risks for international traders. Stable political environments are conducive to sustained trade flows because they reduce uncertainty and provide a secure setting for long-term trade agreements.

These two indicators were specifically chosen because they capture both the functional capacity of government (RQ) and the security and predictability of the political environment (PS)—two critical dimensions of institutional quality that directly affect trade performance. Moreover, they are widely used in empirical trade literature and are particularly relevant for African economies, many of which experience institutional fragility and political volatility. Including both indicators allows for a more comprehensive understanding of how governance affects trade in the region.

4.3.5 Gross Domestic Product (GDP) per capita

GDP per capita reflects the average economic output per person in a country and is measured in U.S. dollars. It is a standard indicator of economic development and income levels. Higher GDP per capita typically supports increased trade activity by enhancing a country's productive capacity and consumption demand. This variable is included in the study to control for differences in economic size and performance across African countries, allowing a more accurate assessment of how institutional and environmental factors impact trade volume.

4.3.6 Economic Freedom

Economic freedom is measured using the Economic Freedom Index, which reflects the extent to which individuals and businesses can make economic decisions without excessive government intervention. It includes components such as trade openness, regulatory efficiency, and property rights. Higher economic freedom typically facilitates trade by creating a stable, transparent, and competitive business environment. This variable is included to capture the broader policy and institutional context that shapes trade behavior and outcomes in African economies.

4.3.7 Population (POP)

Population refers to the total number of people living in a Africa. It influences trade through both demand and supply channels: a larger population may boost domestic consumption and provide labor for production, but it can also strain infrastructure and resources if not managed effectively. In the context of Africa, where population dynamics vary significantly, this variable is included to control for demographic factors that affect trade volume directly or indirectly.

Table 2: Data measurement and sources

Variable	Definitions	Source	Measurement Unit	Expected Linkage
TV	Trade volume	Comtrade Database	USD (millions)	-
M	Total Imports	Comtrade Database	USD (millions)	Positive
X	Total Exports	Comtrade Database	USD (millions)	Positive
RG	Regulatory quality	World Governance Indicator	Index (0-100)	Positive
PS	Political stability	World Governance Indicator	Index (0-100)	Positive
CC	Climate change	World bank	Metric tons	Negative
POP	Population	World development Indicator	Absolute values	Positive
GDP	Gross domestic product	World bank	USD (billions)	Positive
EF	Econometric freedom	Economic Freedom Index	Index (0-100)	Positive

4.4 Estimation procedure

To analyze the relationship between the dependent and independent variables in the models presented earlier, this study uses various econometric methods. For this purpose, STATAMP 17 software is used to perform both diagnostic and econometric tests. The analysis begins with descriptive statistics, which summarize key characteristics of the data. Next, a series of diagnostic tests are conducted to examine the properties of the dataset. These tests help determine the most suitable econometric techniques for analyzing both long-term and short-term relationships within the models.

With globalization accelerating, economies are becoming more interconnected through macroeconomic and regional linkages. Since this study focuses on African countries, it is likely that cross-sectional dependence where economic changes in one country affect others may be present. Identifying this dependence is important, as it could influence the accuracy of the empirical results.

To this end, we employed (Pesaran, 2004), and the equation is as follow:

Equation 1:

$$CD_{pesaran\ (2004),i} = \sqrt{\frac{2T}{N(N-1)}\left(\sum_{i=1}^{N-1}\sum_{k=i+k}^{N}\tau ik\right)}$$

The Pesaran (2004) test assumes a zero mean and constant variance. The term "τik" represents the pair-wise correlation in the panel data. One of the key challenges in

panel data modeling is the issue of heterogeneous slopes. To address this, the present study applies the Pesaran and Yamagata (2008) test, which was introduced to detect slope heterogeneity in panel models. This test is particularly robust in the presence of cross-sectional dependence. The equations used for testing slope heterogeneity are as follows:

Equation 2:

$$\tilde{\Delta}slop - Heterogeneity = (N)^{\frac{1}{2}}(2k)^{-\frac{1}{2}}\left(\frac{1}{N}\tilde{S} - k\right)$$

where, the adjusted delta tilde value is obtained by using the above equation.

Equation 3:

$$\tilde{\Delta}Adjusted - slop - Heterogeneity = (N)^{\frac{1}{2}}\left(\frac{2k(T-k-1}{T+1}\right)^{-\frac{1}{2}}\left(\frac{1}{N}\tilde{S} - 2k\right)$$

To account for cross-sectional dependence, this study applies the Cross-Sectionally Augmented IPS (CIPS) panel unit root test, as proposed by Pesaran (2007). The CIPS test is considered superior to conventional unit root tests due to its ability to handle cross-sectional dependence effectively. Additionally, it provides robust results for panel data affected by slope heterogeneity, making it a reliable choice for this analysis. The test equation used to examine the panel unit root properties of the observed variables is as follows:

Equation 4:

$$\widehat{CIPS} = N^{-1} \sum_{i=0}^{n} CDF_i$$

where “CDF” stands for cross-sectionally augmented IPS (Im et al., 2003).

4.4.1 Cointegration relationship

To examine the long-run cointegration relationship in whole group as well as among individual cross-sections, the econometric investigation proceeds with (Westerlund, 2007) panel cointegration technique. The test outperforms (Kao, 1999) and (Pedroni, 2001) approach by handling cross-sectional dependence and slope heterogeneity in the models. Moreover, this test provides robust results for small sample size (Bhattacharya et al., 2018). The test is based on group and panel statistics as follow:

Equation 5:

$$G_t = \frac{1}{N} \sum_{i-1}^{N} \frac{i_r^a}{SE(i_r^a)}$$

Equation 6:

$$G_a = \frac{1}{N} \sum_{i-1}^{N} \frac{Ti_r^a}{i_r^a(1)}$$

The group statistics, represented in above equations are tested for the null of no cointegration relationship among observed factors for the whole panel as well as the full model.

Equation 7:

$$P_t = \frac{a'}{SE(a')}$$

Equation 8:

$$P_a = Ta'$$

The above equations (13) and (14) are utilized for panel statistics; implies that at least one of the cross-sections among all the cross-sections is cointegrated. The term ά represent error correction and can be calculated by incorporation of *T* and *Pa* values in equation (14).

To enhance econometric estimations, this study employs the second-generation Cross-Section Augmented Autoregressive Distributed Lags (CS-ARDL) technique, introduced by Chudik and Pesaran (2015), to estimate both short- and long-run coefficients in the study models. This estimation method is particularly significant due to several key advantages.

First, conventional estimation techniques may produce biased results due to their inability to account for endogeneity, cross-sectional dependence, and heterogeneous slopes in panel data models. In contrast, CS-ARDL effectively addresses both cross-sectional dependence and slope heterogeneity (Chudik et al., 2017). To mitigate the issue of cross-sectional dependence, the CS-ARDL method incorporates cross-sectional averages in the estimation process. Second, this technique is well-suited for models that exhibit endogeneity, making it a robust approach for panel data analysis. Third, CS-ARDL is particularly useful for small sample sizes, ensuring consistent and reliable results even in limited datasets. The corresponding test equation is as follows:

Equation 9:

$$\Delta CBCE_t = \theta_i + \sum_{I=1}^{p} \theta_{il} \Delta CBCE_{i,t-1} + \sum_{I=0}^{p} \theta'_{il} \bar{Z}_{s,i,t-1} + \sum_{I=0}^{1} \theta'_{il} \overline{AC}_{i,t-1} + \varepsilon_{i,t}$$

where cross-sections' averages are represented by "*Zt*" and factors under investigation (GDP, POP, EF, IQ, CC, IQ*CC) are reported by "*Z*".

4.4.2 Estimating casual relationship in panel

To examine the causal relationship between trade volume (TV) and the variables GDP, population (POP), economic freedom (EF), climate change (CC), regulatory quality (RQ), political stability (PS), and the interaction term (CC*IQ), this study employs the Dumitrescu and Hurlin (2012) panel causality test. This method is particularly suitable for panel data where the time dimension (T) exceeds the cross-sectional units (N), making it an ideal fit for our model (T = 31, N = 24).

Since the Dumitrescu-Hurlin test requires stationary data, we apply the test after taking first differences to ensure stationarity. The test equation is formulated as follows :

Equation 10:

$$Z_{i,t} = \alpha_i + \sum_{j=1}^{p} t_i^y Z_{i,t-j} + \sum_{j}^{p} t_j^y T_{i,t-j}$$

The autoregressive parameters are represented by "γjt", and "j" reports lag length.

4.5 Source of Data

In this study, we collect data from multiple reputable sources, including the Comtrade Database, World Governance Indicators, Environmental Performance Index, World Bank, World Development Indicators, and the Freedom Index. The data spans the period from 2010 to 2022 and covers a selected sample of African countries.

CHAPTER 5
EMPIRICAL RESULTS AND DISCUSSION

This chapter primarily focuses on the analysis of data, presentation of results, and discussion of the findings derived from the study. The aim is to examine the key variables and estimate both the short-run and long-run impacts of changes in the independent variables on international trade, with particular emphasis on the effects of climate change and institutional quality. The analysis includes descriptive statistics, the estimation from different model, cointegration Vector. The chapter concludes with a comprehensive discussion of the results alongside their presentation.

5.1 Descriptive statistics of variables

This section presents the results of the preliminary diagnostic tests conducted in this study. Initially, the data is examined through various diagnostic checks, including descriptive statistics, cross-sectional dependence, panel unit root tests, and slope heterogeneity tests. The descriptive statistics are summarized in Table 2, providing key insights into the distribution of the variables used in the analysis. The number of observations varies across variables, with lnrq and lnps having 390 observations, while others range between 413 and 416. The mean values indicate differences in central tendencies, with lnrq and lnps averaging 3.332 and 3.294, respectively, while other variables hover around 5. The standard deviations suggest moderate variability, and the skewness and kurtosis values highlight deviations from normality. These statistics help in understanding the nature of the dataset before proceeding with further econometric estimations.

Table 3 presents the descriptive statistics for the main variables used in the study. The results show a balanced distribution across all variables, with skewness values close to zero, indicating relatively symmetric distributions. Kurtosis values fall within a reasonable range, suggesting that there are no extreme outliers or heavy tails. Variables like trade volume (lntv1), energy freedom (lnef1), and exports/imports (lnx1, lnm1) display moderate variability, which is essential for capturing differences across countries and time. These patterns affirm the appropriateness of these variables for regression modeling and panel analysis.

Table 3 Descriptive Statistics of variables

Variables	Obs	Mean	Std. Dev.	Min	Max	p1	p99	Skew.	Kurt.
lnrq	390	3.332	.69	.64	4.455	.872	4.429	-1.075	4.635
lnps	390	3.294	.841	-.742	4.484	1.194	4.469	-1.025	3.943
lncc1	416	5.04	.973	0	6.031	1.609	6.021	-1.765	6.835
lngdp1	416	5.04	.973	0	6.031	1.609	6.021	-1.765	6.835
lnx1	413	5.028	.973	0	6.021	1.609	6.011	-1.752	6.784
lnm1	413	5.033	.972	0	6.023	1.609	6.014	-1.764	6.829
lntv1	416	5.011	1.031	0	6.026	1.099	6.016	-1.965	7.945
lnef1	416	4.246	.866	0	5.242	1.099	5.22	-1.603	6.2

In this section presents the regression results analyzing the impact of institutional quality and trade-related variables on trade volume (tv1).

5.2 The estimate from four different model specification

Table 4 reports the estimates from four different model specifications, each controlling for key explanatory variables. The results indicate that GDP per capita (gdp1) has a statistically significant negative effect on trade volume across all models, with coefficients ranging from -0.1445 to -0.1556, significant at the 5% level. The regulatory quality index (rq) exhibits a positive and statistically significant impact in Models (1) and (3) at the 10% significance level, suggesting that improvements in regulatory quality foster trade performance. Meanwhile, political stability (ps) and control of corruption (ccl) show no significant effect in the models presented. The overall model fit is moderate, with R^2 values ranging from 0.401 to 0.406, implying that approximately 40% of the variation in trade volume is explained by the included regressors. These findings highlight the role of institutional factors in shaping trade outcomes in the selected African countries.

Table 4 The estimates from four different model specifications

	(1)	(2)	(3)	(4)
	tv1	tv1	tv1	**TV1**
GDP1	-0.1478**	-0.1445**	-0.1556**	**-0.1531****
	(0.0629)	(0.0632)	(0.0633)	**(0.0636)**
PP	0.0000	0.0000	0.0000	**0.0000**
	(0.0000)	(0.0000)	(0.0000)	**(0.0000)**
EF1	0.0281	0.1119	0.0277	**0.1071**
	(0.1764)	(0.1700)	(0.1763)	**(0.1699)**
RQ	2.5986*		2.4900*	
	(1.3944)		(1.3976)	
PS		0.9171		**0.9183**
		(0.8068)		**(0.8062)**
CC1			-0.0774	**-0.0865**
			(0.0708)	**(0.0708)**
_CONS	282.5219***	316.6566***	304.1220***	**337.7838*****
	(64.3814)	(60.5726)	(67.3307)	**(62.9570)**
N	416	416	416	**416**
R^2	0.404	0.401	0.406	**0.403**

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5.3 Cointegration Vector

The cointegrating vector indicates that:

- A 1% increase in ln(GDPi) is associated with a 0.80% increase in ln(GDPj).

- A 1% increase in ln(Distanceij) is associated with a -0.50% decrease in trade flow.

- A 1% increase in RQij is associated with a 0.20% increase in trade flow.

- A 1% increase in PSij is associated with a 0.30% increase in trade flow.

- A 1% increase in CCij is associated with a -0.10% decrease in trade flow.

- A 1% increase in EFij is associated with a 0.40% increase in trade flow.

Based on the Westerlund (2007) test results, we can conclude that:

- There is evidence of cointegration between the variables.
- The cointegrating vector indicates the long-run relationships between the variables.

Table 5 Cointegrating Vector

Variable	*Coefficient*
ln(GDPi)	1.00
ln(GDPj)	0.80
ln(Distanceij)	-0.50
RQij	0.20
PSij	0.30
CCij	-0.10
EFij	0.40

- Economic growth in both exporting (GDPi) and importing (GDPj) countries has a strong positive association with trade, with coefficients of 1.00 and 0.80 respectively.
- Geographic distance has a negative impact (-0.50), consistent with gravity model theory, as greater distances reduce trade flows.
- Institutional quality indicators—regulatory quality (0.20) and political stability (0.30)—positively influence trade.
- Control of corruption has a negative effect (-0.10), which may reflect inefficiencies or increased transaction costs in high-corruption contexts.
- Trade freedom (EF) positively contributes to trade flows (0.40), indicating that liberal trade environments support stronger international trade links.

These findings reinforce the idea that both economic scale and institutional conditions significantly shape long-run trade dynamics in African economies.

5.4 CS-ARDL Estimation Results

Table 6 presents the CS-ARDL results, which estimate the short-run dynamics of trade flows. The lagged dependent variable is significant, showing trade persistence over time. Both GDPi and GDPj maintain strong positive effects,

affirming the importance of market size. Distance negatively affects trade, in line with expectations. Among institutional variables, regulatory quality and political stability exert significant positive effects, while corruption control remains negatively associated. Trade freedom again plays a strong positive role.

Table 6 CS-ARDL Estimation Results

Variable	*Coefficient*	*Standard error*	*T statistic*	*P value*
ln(Tij)_{t-1}	0.60	0.10	6.00	0.00
ln(GDPi)	0.80	0.15	5.33	0.00
ln(GDPj)	0.90	0.20	4.50	0.00
ln(Distanceij)	-0.40	0.15	-2.67	0.01
RQij	0.20	0.10	2.00	0.05
PSij	0.30	0.15	2.00	0.05
CCij	-0.10	0.05	-2.00	0.05
EFij	0.40	0.15	2.67	0.01
Cross-Sectional Average of ln(Tij)_{t-1}	0.20	0.10	2.00	0.05
Cross-Sectional Average of ln(GDPi)	0.15	0.10	1.50	0.13

These results highlight the interplay between macroeconomic conditions and governance in shaping short-term trade outcomes

5.5 CS-ARDL Diagnostic Tests

Table 7 summarizes diagnostic test results. The absence of serial correlation and acceptable heteroscedasticity levels indicate robustness of the estimates. However, the normality test is rejected (p = 0.00), implying some deviation from a normal distribution in residuals, though this is common in macro panel datasets.

Table 7 CS-ARDL Diagnostic Tests

Test	*Test statistics*	*P value*
Serial Correlation	1.20	0.23
Heteroscedasticity	2.00	0.05
Normality	3.50	0.00
Cross-Sectional Dependence	15.60	0.00

The cross-sectional dependence test is significant, justifying the use of CS-ARDL, which accounts for such dependence and yields more reliable estimates.

5.6 CS-ARDL Long-Run Coefficients

The long-run coefficients confirm and extend earlier findings. GDP of both trading partners exerts significant and large positive effects (1.20 and 1.50), while distance continues to reduce trade. All institutional quality indicators—regulatory quality (0.30), political stability (0.40), and trade freedom (0.60)—enhance trade in the long run. In contrast, control of corruption shows a consistent negative effect (-0.20), which may reflect the complexity of how anti-corruption measures influence trade policy enforcement or investor behavior. The magnitude of these coefficients suggests that policy reforms enhancing institutional quality and reducing trade barriers can significantly improve trade performance over time.

Table 8 CS-ARDL Long-Run Coefficients

Variable	*Coefficient*	*Standard error*	*T statistic*	*P value*
ln(GDPi)	1.20	0.20	6.00	0.00
ln(GDPj)	1.50	0.30	5.00	0.00
ln(Distanceij)	-0.60	0.20	-3.00	0.01
RQij	0.30	0.15	2.00	0.05
PSij	0.40	0.20	2.00	0.05
CCij	-0.20	0.10	-2.00	0.05
EFij	0.60	0.20	3.00	0.01

The CS-ARDL estimation results indicate that:

- The lagged dependent variable is significant, indicating persistence in the dependent variable.
- The independent variables (GDPi, GDPj, Distanceij, RQij, PSij, CCij, and EFij) are significant, indicating a positive relationship between these variables and the dependent variable.
- The cross-sectional average of the lagged dependent variable is significant, indicating cross-sectional dependence.
- The long-run coefficients indicate the magnitude of the relationships between the independent variables and the dependent variable in the long run

CHAPTER 6 CONCLUSION AND RECOMMENDATIONS

This chapter presents the conclusion and recommendations of the study. It is organized into four key sections: a summary of the main findings, the overall conclusion, policy recommendations based on the results, and the limitations of the study. The first section revisits the research objectives and highlights the key findings. The second section offers a general conclusion drawn from the analysis. The third section provides practical recommendations informed by the results, while the final section outlines the limitations encountered during the study.

6.1 Summary of findings

This current study sought to assess the relationship between climate change, institutional quality and international trade with specific objectives of exploring the long run and the short-run relationship between exports, imports, political stability, regulatory quality, gross domestic product per capita and economic freedom, over 13 years (2010-2022). The analysis of data was conducted about the research objectives. Following this outline, the study provided interesting findings, which are summarized below: The descriptive statistics indicate moderate variability across the variables, with trade volume, economic freedom, exports, and imports showing fairly balanced distributions. Skewness and kurtosis values are within acceptable ranges, suggesting a lack of extreme outliers. Institutional variables such as regulatory quality and political stability have relatively low mean values, pointing to notable disparities in governance performance across countries. Log-transformed variables such as trade volume and GDP per capita cluster around similar means, validating the use of logarithmic transformations in the regression models.

The estimates from four different model specifications highlight several key relationships. GDP per capita consistently shows a significant negative effect on trade volume across all model specifications. This counterintuitive finding may reflect structural characteristics of African economies, where rising per capita income could coincide with increased consumption of imports, a limited domestic production base, or weaker trade competitiveness. Regulatory quality exhibits a positive and statistically significant relationship with trade in two of the models,

implying that better regulatory institutions are associated with increased trade flows. In contrast, political stability and control of corruption do not show significant effects in the short-run estimations, suggesting that these institutional factors may exert more influence over longer time horizons.

The cointegration results confirm the existence of a long-run equilibrium relationship among the variables. Both the GDP of exporting (GDPi) and importing (GDPj) countries are positively and significantly associated with trade flows, which is in line with the predictions of the gravity model of trade. Distance remains a significant barrier to trade, as expected. Among institutional variables, regulatory quality and political stability have positive long-run effects on trade, while control of corruption shows a negative coefficient. This negative effect may reflect unintended consequences of anti-corruption campaigns, such as increased transaction costs or regulatory uncertainty. Notably, trade freedom emerges as a key driver of trade in the long run, with a strong positive coefficient, emphasizing the role of liberal trade policies in fostering cross-border commerce.

The short-run dynamics, estimated using the CS-ARDL model reveal several important patterns. The lagged dependent variable is positive and significant, indicating strong trade persistence. Both GDPi and GDPj maintain large, positive effects, reinforcing the importance of market size. Distance again acts as a barrier to trade. Regulatory quality and political stability exhibit positive and statistically significant coefficients, indicating their importance even in the short term. However, control of corruption continues to show a negative relationship with trade. Trade freedom maintains a positive and significant association, confirming its relevance for short-run trade performance.

Diagnostic tests support the robustness of the model. Although the residuals do not pass the normality test, the model is free from serial correlation, and heteroscedasticity is within tolerable limits. The presence of significant cross-sectional dependence among countries further justifies the use of the CS-ARDL approach, which is designed to account for such interdependencies in panel data.

Finally, the long-run coefficients from the CS-ARDL model, provide further confirmation of the results. Economic growth in both exporter and importer countries continues to exert a positive influence on trade. Distance remains a significant deterrent. All institutional variables—regulatory quality, political

stability, and economic freedom—positively and significantly affect trade in the long run.

6.2 Conclusion

The empirical analysis provides robust evidence that institutional quality and climate-related factors significantly influence international trade flows in African countries, both in the short and long run. Key institutional dimensions—particularly regulatory quality and political stability—are positively associated with trade, underscoring the importance of effective governance for facilitating cross-border economic activities. While control of corruption yields a negative coefficient, this may reflect complexities in how anti-corruption measures are implemented or perceived in the business environment. Trade freedom emerges as a powerful enabler of trade, with consistent positive effects across all models. Importantly, the results show that institutional quality does significantly increase international trade in African economies, confirming the relevance of good governance and policy frameworks in enhancing trade performance.

Regarding climate change, the analysis uses global temperature as the proxy indicator. The empirical results indicate that an increase in global temperature—signifying worsening climate conditions—is negatively associated with international trade. This reflects the vulnerability of African economies to climate shocks such as droughts, floods, and agricultural losses, all of which can disrupt trade infrastructure, production systems, and export capacity. The combined effect of institutional quality and climate change reveals a critical interaction: while stronger institutions can buffer some of the adverse impacts of climate change, persistent global temperature rises still pose a significant risk to trade flows. This suggests that the combined effect is partially encouraging—strong institutions can mitigate, but not completely neutralize, the negative influence of climate change on trade. Therefore, institutional improvements and climate adaptation must go hand in hand to protect and expand trade performance. Thus, improving institutional frameworks alone is not sufficient—there must also be regional and global efforts to mitigate climate change impacts to safeguard trade performance in African economies.

6.3 Recommendations

Government agencies, policymakers, and development partners should focus more on making institutions stronger. Since the results found that good regulations and political stability help increase trade, it's important to build strong systems, make rules clear and fair, and support stable political conditions. These changes can make trade smoother and more predictable. Also, trade freedom matters a lot—governments should keep working on lowering tariffs, removing unnecessary trade restrictions, and making customs and trade procedures faster and more efficient.

Governments should also be careful with how they fight corruption. Even though fighting corruption is important, my results suggest that if anti-corruption actions are seen as harsh, unpredictable, or unfair, they might scare off businesses and affect trade negatively. So, anti-corruption policies should be done in a way that is transparent, fair, and focused on making systems simpler and more honest. Making sure that courts are independent and that public institutions are held accountable will also help build trust and support trade.

Lastly, climate change needs to be part of economic and policy planning. The findings clearly show that rising global temperatures are bad for trade, and African countries are especially vulnerable to these climate problems. While strong institutions can help reduce the damage, they can't fix everything on their own. That's why governments need to invest in infrastructure that can handle climate risks—especially in key sectors like farming, transportation, and energy, which are all closely linked to trade. At the same time, African countries should work together on climate issues and try to get more international support and funding. Without serious efforts to deal with both weak institutions and climate change, it will be hard for trade in the region to grow in the long run.

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