**SIMON DIEDONG DOMBO UNIVERSITY OF BUSINESS AND INTEGRATED DEVELOPMENT STUDIES**

# THE EFFECT OF FINANCIAL DEVELOPMENT ON INFRASTRUCTURE DEVELOPMENT IN GHANA

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**THIS THESIS IS SUBMITTED TO THE DEPARTMENT OF BANKING AND FINANCE, SCHOOL OF BUSINESS AND LAW, SIMON DIEDONG DOMBO UNIVERSITY OF BUSINESS AND INTEGRATED DEVELOPMENT STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF PHILOSOPHY IN FINANCE.**

**SEPTEMBER, 2023**

DECLARATION

I hereby declare that this work is the result of my own research and has not been presented by anyone for any academic purposes at the Simon Diedong Dombo University of Business and Integrated Development Studies or any other university. All works used in the study have been duly recognized.

**……………………………………**

Samuel Dakurah

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**Date: 23rd September, 2023**

# CERTIFICATION

I hereby certify that this thesis was supervised according to the procedures that have been laid down by the Simon Diedong Dombo University of Business and Integrated Development Studies and in line with international scholarly protocols.

**… …**

**Professor Joseph Nyeadi**

**(Supervisor)**

**..24th September, 2023...**
**Date**

## DEDICATION

This work is first and foremost dedicated to my wife Faustina Naagmenlakpio Sibiri, and my entire family for the unwavering love and support shown me all my life.

# ACKNOWLEDGEMENT

Firstly, I give thanks to God for this journey. I am indebted to my supervisor, Professor Joseph Nyeadi, for his dedication, mentorship, correction, and direction during the supervision of this work. Special thanks to the faculty members and my colleagues.

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# ABSTRACT

This study investigated the impact of financial development on infrastructure development in Ghana. The research comprehensively examined how a well-established financial sector influences infrastructure development and the extent of this influence. The study employed a quantitative research design and utilized time series models to analyze data spanning three decades, from 1990 to 2020. Descriptive statistics were predominantly used to analyze the data. The results indicated a significant and positive correlation between Financial Development and Infrastructure Development, as confirmed through the Granger Causality test. The findings also pointed to a durable relationship between these variables, as observed in the data analysis. This suggests that financial development holds predictive power in elucidating fluctuations in infrastructure development, underscoring its substantial role in shaping infrastructure growth. This correlation was further corroborated by the threshold effect, which highlights meaningful relationships between the variables with both statistical and practical significance. However, subsequent research could delve into assessing the enduring effects of diverse financing models on various outcomes of infrastructure development, including economic growth, employment, and social development indicators. A comprehensive understanding of the broader implications of these financing models can serve as valuable input for future policy decisions and investment strategies.

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background of the study

Financial development is a crucial pillar for the progress of nations, serving as the backbone of a country's economy (Nkemgha, Nchofoung, and Sundjo, 2022). The World Bank (2020) highlights how financial development often hampers economic growth in many countries. As a result, financial development emerges as a significant hurdle to overall development. The variation in financial development across countries and within African nations is notable (Anyawu, 2017). Some countries exhibit well-structured financial sectors that support economic growth, while others grapple with inadequate financial development (Ahmed, 2017). This discrepancy is intricately linked to the capacity of a country's infrastructure to underpin its economy. Countries with robust financial sectors generally possess strong infrastructure systems (World Bank, 2017). Contrary to common belief, countries with weak financial sectors often experience substantial infrastructure deficits, emphasizing the importance of well-established infrastructure for a nation's functionality (Nafar, 2019).

Financial development can evolve either through domestic financial capacity or foreign sources. When domestic finance lacks the strength to support infrastructure projects, foreign funds are often sought (African Development Bank, 2018). Financial development significantly impacts domestic investment in various countries, influencing the quality of infrastructure development (Nafar, 2019). This interconnectedness emphasizes the integral relationship between financial development and infrastructure. Weaker financial development in some countries prompts them to rely on foreign aid for infrastructure

(Affum and Obiri, 2020). A well-structured financial system is paramount for achieving sustainable economic growth (Esso, 2010). Developing nations often struggle with weaker financial development modules, hampering infrastructure progress. Malick (2017) attributes this challenge to factors like slow economic growth, migration, climate change, and global unemployment, which impact the economic landscape. Such problems necessitate Africa's economic prosperity, driven by infrastructure-enabled industrial development to alleviate poverty (Malick, 2017). Gender disparities also play a role, with AFAWA (2020) indicating a significant financing gap for women in Africa, particularly in the agricultural sector. This further highlights the importance of robust financial systems for inclusive development.

The United Nations Conference on Trade and Development (UNCTAD) estimated a substantial annual funding requirement for infrastructure development in developing countries to realize the Sustainable Development Goals (SDGs) (UNCTAD, 2014). The reliance on domestic financial sectors and investments for infrastructure funding poses challenges due to underdeveloped financial sectors in many developing countries (Dutta and Jeerh, 2023). As a result, external financial assistance in the form of loans, grants, and foreign investments becomes necessary for these nations. A well-built domestic financial sector offers the advantage of independently determining infrastructure investments, without relying on foreign assistance (African Development Bank, 2018). However, many developing countries struggle to raise sufficient resources domestically due to factors such as external debt burdens and inadequate revenue mobilization (OECD, 2015). This leads to a heavy dependence on foreign partners for infrastructure funding. Foreign Direct Investments (FDIs) and Build, Operate, and Transfer (BOT) arrangements, though used, might not be reliable sources for large-scale infrastructure projects (Fosu and Aryeetey, 2008).

The Ugandan economy illustrates the critical role of a resilient domestic financial sector in supporting infrastructure development (Girma and Gong, 2008). A similar challenge is observed in countries like Ghana (GIP, 2021; World Bank, 2010), where the struggle to develop a robust financial sector impedes infrastructure progress. Developing countries often turn to foreign investments, grants, and loans to enhance their financial sectors (Bijlsma, Kool, and Non 2018), highlighting the need for self-sustained domestic finance development. Ghana's infrastructure development plan often relies on foreign financing, leading to a significant infrastructural deficit (Mante, 2020). The country's ability to build a strong financial system is crucial for robust infrastructure (AICD, 2011). While foreign investments are considered, their potential to weaken domestic financial development is noted (Bijlsma, Kool, and Non, 2018).

AICD (2010) emphasizes that Ghana's housing deficit can be attributed to the lack of a robust domestic financial sector to support infrastructure. The financial sector plays a pivotal role in channeling resources for infrastructure development (Affum and Obiri, 2020). Efforts to strengthen the financial sector, such as banking clean-ups, have implications for the government's access to funds for infrastructure (Francisca and Tanaka, 2019). Nafar (2019) underscores the necessity of structured financial plans for infrastructure development worldwide. Open economies that encourage trade and financial flow exhibit enhanced financial development (Baltagi, Demetriades, and Law, 2007). This highlights the interplay between international trade policies and domestic financial growth.

Ghana's increased annual infrastructure financing over a decade underscores the dependence on external sources, leading to concerns about debt burdens (GIP, 2021). While Ghana's financial sector has experienced growth, turbulences persist, making it vital to explore the impact of domestic financial development on infrastructure. Understanding the interrelation between financial development and infrastructure is crucial for devising effective funding strategies and enhancing self-sustained growth.

### 1.2 Statement of the problem

Ghana has faced significant challenges in its financial development over the last decade. The inadequate development of the domestic financial market has hindered the government's ability to support infrastructure projects (Abokyi, Appiah-Konadu, Sikayena and Oteng-Abayie,). The Auditor General's report highlighted the issue of insufficient funds for infrastructure financing, resulting in unfinished or delayed projects and financial losses for the state. This lack of ready funds within the country for project financing leads to delays, reevaluations, and increased project costs due to re-awarding of contracts. The overreliance on external funding sources, rather than domestic ones, has contributed to this financial dilemma (Francisco and Tanaka, 2019). Furthermore, a weakened financial sector has broader implications, leading to a financial crisis for both domestic and external creditors, described as a "credit crunch," characterized by a reduction in money supply, loss of confidence, and non-compliance with debt obligations (Gockel, 2020).

Ghana's strategy to address its infrastructure deficit, outlined in the Ghana Infrastructure Plan (GIP), has heavily leaned on external loans, foreign direct investments (FDIs), and grants, overshadowing the importance of a well-developed domestic financial sector (GIP, 2021). However, this study aims to explore the underappreciated link between a strong domestic financial sector and infrastructure development in Ghana. Prior research, such as Nkemgha, Nchofoung, and Sundjo (2022), focused on African countries' social and capital infrastructure without dissecting the specific impact of financial sector development. This study seeks to fill this gap by examining the causal relationship between financial development and infrastructure growth in Ghana. The country's recent financial sector instability, marked by the banking sector cleanup and domestic debt exchange program, has underscored the need to analyze how financial development influences infrastructure development at the country level.

### 1.3 Research objectives

1. To examine the relationship between financial development and infrastructure development in Ghana.
2. To examine the short and long-term relationships between financial development and infrastructure development in Ghana.
3. To determine threshold effect of financial development on infrastructure development.

### 1.4 Research questions

1. What is the relationship between financial development and infrastructure development in Ghana?
2. What is the short- and long-term relationship between financial development and infrastructure development in Ghana?
3. What are the threshold effects financial development influences infrastructure development?

### 1.5 Significance of the study

This study draws upon a wide range of contributions from sector specialists in Ghana and across the globe. Hence, the study contributes to knowledge on domestic finance development in developing countries. It also raises awareness about the need to develop the domestic financial sector to enable the government to get access to finance to undertake infrastructure development in the country.

The study collected data from consultants and greatly benefited from feedback provided by the relevant stakeholders in the country. It therefore heightens our knowledge of the non-existence of comprehensive data on infrastructure financing in Ghana. The study will thus investigate the effect of this domestic financing of infrastructure and the likely challenges it poses as far as accountability is concerned. Our study is different from much of the research undertaken in this sector.

The findings of this research work offer constructive recommendations to policymakers on how financial development can be enhanced and directed towards its effective implementation in infrastructure development. Furthermore, the study identifies some major financial instruments and traces their impact on infrastructure development. In addition, the study explores and recommends potential areas in which various governments and their agencies are expected to place much effort into developing the financial sector to ensure infrastructural development.

Moreover, the findings of the study provide a guide to investors on where to invest and how to manage their investments effectively for better returns and will not be caught in the auditor general’s reports. This thesis exemplifies one of the research projects that justifies workable strategies for mitigating infrastructure development.

### 1.6 Scope of the study

This study is targeted to examine the effect financial development has on infrastructure development in Ghana. The study will use a quantitative research design by employing a time series data analysis. The study also employed infrastructure development and financial development as the dependent and independent variable respectively as captured in the research topic. The study will also draw data from international monetary fund, word bank and African Development bank database by focusing on only Ghana to examine this linkage at a country level. The study is expected to take less than one year to be completed.

### 1.7 Organization of the study

This study is arranged into five chapters. It begins with Chapter One which contains background to the study, a statement of the problem, objectives of the study, research questions, the significance of the study, and the organization of the study. Chapter two reviewed detailed literature on related areas of the study. This chapter also reviews theoretical and conceptual framework of related studies, identifying gaps and similarities. Chapter Three zoomed into the research methodology, identifying steps and processes of the research. Research design, target population, sample size, sample selection, data collection instruments, instrument validity, and reliability are all aspects of the research methodology used. This chapter also includes data gathering procedures and methodologies, data analysis methods, the profile of the chosen organization, and ethical considerations. The fourth chapter discusses the findings' analysis and interpretation. Finally, chapter five concludes with recommendations and proposals for future research.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.0 Introduction

Financial development has generated interest from numerous researchers and scholars to investigate the subject area. Because of its volatility, it has frequently served as a focal point for debate and research. The research on financial development delved into other areas, including infrastructure development, social capital investment, economic growth, and governance. This chapter therefore begins with theoretical reviews, analyzing various theories used in similar studies and the strengths and weaknesses they have added to the research. Following, various conceptual frameworks have been discussed to give an understanding of the various areas that this research covers. Also, the chapter delved into the empirical reviews of literature, considering geography, level of development, and other geopolitical markings.

## 2.1 Theoretical Literature

The available theoretical literature on the causal relationship between financial development and infrastructural development is relatively limited compared to the extensive literature on financial development's linkage to economic growth. This scarcity prompted this study to draw upon related theories and frameworks to understand the theoretical underpinnings. One prominent theoretical perspective discussed by Asamoah and Botchway (2021) is the finance-led growth theory, rooted in the works of Schumpeter (1911), McKinnon (1973), and Shaw (1973). This theory posits that a well-developed financial sector drives economic growth, suggesting that financial development impacts economic expansion.

Another theoretical framework, growth-led finance, presents an alternative viewpoint by proposing that economic growth influences financial development. Notable scholars advocating this perspective include Romer (1990), Robinson (1952), and Odhiambo (2010). While both theories are significant, their applicability depends on the specific context of the study. Frimpong, Akwaa-Sekyi, Sackey, and Sole (2022) used the theory of diversification in conducting similar research on financial development and infrastructure development in Ghana. As evidence for raising reliable funds to finance equity risk capital, the diversification theory was used to study venture capital fundraising from various institutions and geographical sources. The research is able to identify various sources of venture capital funding and equity risk capital fundraising thanks to the theory. However, this theory has been a fundamental flaw for this study due to the diversified nature of data collection techniques, while this study specifically collected data related to the funds drawn from the domestic financial sector to enhance infrastructural development (Rahman et al., 2021).

Also, the diversification theory allows for a broader gathering of data and integrates both internal and external flows of finances in domestic financial development. It also allows for the assessment of the impact of other thematic areas of the economy, such as infrastructure development and economic growth. However, though this is a very broad theory that allows space for analyzing the objectives of this study, there is a more suitable theory in bivariate causality that specifically analyses two variables of this nature. Bivariate causality tested the relationship between independent and dependent variables, such as financial development and infrastructure development. This makes this study exceptionally inappropriate for the adoption of diversification theory in the analysis.

Frimpong and Oteng-Abayie (2013) used bivariate causality in establishing a causal link between FDI and gross domestic product (GDP) growth in Ghana. This study used the Granger causality test and was supported by a more robust Toda-Yamamoto (1995) Granger causality test to close the loopholes in the main Granger causality test used in the study. This created an integration system to accommodate Granger causality and Toda-Yamamoto to ensure the viability of the data collection and testing. The study also found no general causality between FDI and GDP growth from 1970 to 2002.

This implies that FDI inflows into the country have not improved economic growth during this time period. However, this confirms Esso's (2010) research position that FDI weakens financial development if it does not promote economic growth. Odhiambo (2009) confirms that FDIs negatively affect the financial sector. Nonetheless, the theoretical frameworks are important in the process of running the causality, so they are used in this study. As a result of the robustness of the bivariate causality, which allows for the testing of two forms of variables within the sampled data. As a result, in this study, the bivariate causality of Granger Causality was used. This also allows for a direct causality test of the two variables involved.

Infrastructure's crucial role within this relationship is also addressed in the theoretical literature. Murphy et al. (1989) emphasize that fundamental infrastructure, encompassing economic and social aspects, is essential for both financial and economic development. This underscores the need for simultaneous development in infrastructure and financial sectors to achieve sustained growth. Marwa and Zhanje (2015) introduce a mutual reliance theory, suggesting that financial development and economic growth are interdependent and co-supportive. However, some scholars like Manu (2017) challenge this notion, arguing that one variable can operate independently from the other.

Another perspective introduced by Christopoulos and Tsionas (2004) proposes that economic growth takes precedence over financial development. In contrast, Nkemgha et al. (2023) propose a formulation that positions financial sector development as a precursor to infrastructure development. This concept highlights the crucial role of a well-developed financial sector in supporting infrastructure growth, human development, and poverty reduction. It also aligns with the idea that financial sector development contributes significantly to achieving sustainable development goals, as articulated by the African Development Bank (2018).

Agyapong, Asiamah, and Crabbe (2019) studied the impact of capital inflows on Ghana's domestic financial development. The Johansen and Juselius multivariate co-integration approach was used in this investigation to determine the relationship between capital inflows and financial development in Ghana. It was discovered that foreign direct investment (FDI), external debt, and remittances had a negative impact on the development of Ghana's banking system. Foreign loans have both immediate and potentially detrimental effects on Ghana's local financial development. This study looked at how capital inflows affect the development of Ghana's financial industry.

Therefore, the theoretical literature directly exploring the causal relationship between financial development and infrastructural development is limited, scholars have drawn from related theories to illuminate their interconnectedness. The finance-led growth theory highlights the impact of financial development on economic growth, whereas growth-led finance posits a reverse relationship. The importance of infrastructure within this dynamic is emphasized, underscoring the need for coordinated development in both sectors. These theories collectively provide valuable perspectives for understanding the intricate interplay between financial development and infrastructural growth.

### 2.2 Conceptual review

Concepts are very crucial to this study. They identify the integral aspects of the study and modulate the research themes. Concepts also organized the research into perspectives and definitions, allowing for a better understanding of the research's boundaries. Concepts such as finance development and infrastructure development. These are further discussed below to guide the content of the study.

#### 2.2.1 Financial development

Providing an acceptable definition of financial development has become one of the most difficult tasks for finance scholars and researchers, making it more complex than it appears. Several academics have proposed different definitions of financial development. Among these scholars is Joseph Schumpeter, who lived in 1912 and whose definition has gained traction in finance and development circles around the world. Contemporary scholars such as Giorgio (1999) delved deep into Schumpeter’s definition to carve out a definition of "financial instruments" as those that help in the movement and accumulation of finances within a certain platform. Financial development refers to the accumulation and creation of domestic finance, which can either circulate within the economy to stimulate economic growth, as in China (Xu et al., 2020), or circulate somewhat outside the economy.

However, this definition has captured a broad category of finance, including inflows and outflows within an economy. Zhu et al. (2022) believed that financial development should be the undertaking of state agencies to enable them to create green financial development.

However, according to Duan (2021), the current state of financial development has a negative impact on developing countries' financial development because of the global financial sector's stringent regulations. Hauner (2009) classified the regulations of these financial instruments within the platform or geographical areas as fiscal policy. These policies govern the global financial sector, while domestic regulations follow the global financial market (Torun and Aslan, 2022).

Also, Krinischansky and Annenskaya (2022) explained that financial development is the result of alterations that help reduce explicit and implicit costs related to the work of the financial system and providing its functions. It is characterized by various configurations and scenarios depending on the place and time. This definition has broadly defined the term "financial development" to include any movement within the financial sector, including external movements. These included the inflow and outflow of funds within the financial sector, changes to the financial system, increasing and decreasing capital formation, and financial system regulation.

However, the upsurge of digital finances and expanded financial inclusion of areas that were initially not considered part of the financial sector make defining the financial sector's development "polysemy" (Krinischansky and Annenskaya, 2022). Levine (2004), in an equally broader view, expressed financial development as involving the improvements of "production of ex-ante information about possible investments; monitoring of investments and implementation of corporate governance; trading, diversification, and management of risk; mobilization and pooling of savings; and exchange of goods and services. These listings have captured the entire financial sector of a country, including global financial systems. Financial development can be loosely defined to encapsulate whatever happens in the financial sector in terms of the accumulation and circulation of capital.

Torun and Aslan (2022) proposed a concept of financial development that includes decisions to save and invest in order to accumulate capital and make sufficient transfers to areas of need in the economy to boost economic growth. In addition, financial development comprises "qualitative and quantitative improvements in financial intermediation services, as well as a positive process in system efficiency" (Torun and Aslan, 2022). This definition differs from the others in that it includes a qualitative and quantitative improvement of the financial sector in order to encourage economic growth. The primary goal of financial development is to amass domestic money that can then be utilized for development projects. According to Marvasti and Razzaghi (2020), most African countries struggle to accumulate capital due to insufficient savings or financial circulation.

Moreover, in the domestic banking sector, to supply the government with access to funding for development projects. Because there is no uniform definition of financial development, numerous economists have discussed it from comparable but unique perspectives. According to the World Bank (2019), financial development is "the processing of carrying out contracts, abating the charges of obtaining instructions, and performing operations. According to Shabbir et al. (2018), financial development may be defined as characteristics, regulations, and procedures that aid in the establishment of access to economic operations and steer a country toward successful financial intermediaries and institutions.

### 2.2.2 Infrastructure development

Infrastructure development involves the improvement of the various aspects of infrastructure in a country, which aids in the smooth administration of the lives of its citizens. Infrastructure development includes hard and soft projects to ensure the wellbeing of the citizens. Infrastructure development includes projects in energy, communication, social and commercial, transport, water, and sanitation (Edward et al, 2013). Governments invest in these infrastructures to ensure smooth administration, the welfare of the citizens, and stimulate economic growth through businesses. Saini and Gini (2022) explained infrastructure development as a pre-requisite for transforming a country from a lower-performing country to an advanced country. The definition categorized infrastructure development as a hard and soft project that can transform a country's standing and economic activities (Dutta and Jeerh, 2023). These include transportation infrastructure, the energy sector, communication, etc., which are very vital for a country's economic activities and growth (Edward et al., 2013).

The African Development Bank (2022) has identified infrastructure development as the basic driver for growth and a critical trigger of productivity and sustainable economic growth. Infrastructure development is a fundamental stimulator for businesses and economic growth. Every economy relies on infrastructure for progress and development. The absence of these facilities or enablers presents a difficult situation for economic activities vis-à-vis growth and development. Akwada and Akinlabi (2018) explained infrastructural development as an important ingredient in the development of every country. These are factors that lay the foundation for economic growth. Infrastructural development is therefore crucial to the development agenda. The readily available infrastructure determines the availability of resources in the country.

## 2.3 Empirical literature review

### 2.3.1 Positive link

The study conducted by Nkemgha, Nchofoung, and Sundjo (2022) focused on the relationship between financial development, human capital thresholds, and infrastructure development across 33 African countries using the Generalized Method of Moments (GMM) model. The GMM model was chosen for its suitability in analyzing a wide range of data variables across specific time frames, allowing the study to explore correlations within the 2003–2019 period. The research revealed a strong connection between financial development and human capital thresholds with infrastructure development in Africa. However, the study's focus on two variables (financial development and human capital) led to negative regression results, indicating a potential interplay between the variables that could affect infrastructure development.

While Nkemgha et al. (2022) utilized GMM to analyze multiple variables over time, this method wasn't directly suitable for the current investigation, which involves the interaction of financial development and infrastructure development specifically within Ghana. The study's unique dual-variable nature necessitated either cross-sectional or time series data analysis. Cross-sectional data wouldn't capture the desired temporal relationship, making time series data more appropriate. Creswell and Creswell (2018) emphasized the importance of aligning suitable methodologies with research objectives, as an improper choice can hinder data collection and hypothesis testing.

In a similar vein, Takyi and Obeng (2013) employed the Autoregressive Distributed Lag (ARDL) approach to establish an economic model for financial development, but they couldn't conclusively determine causal relationships between financial development and infrastructure development. This aligns with observations by Wessel (2019), who highlighted the complexities of financial inflows impacting domestic financial sectors without directly translating to infrastructure development. Adam and Tweneboah (2013) examined foreign direct investment (FDI) impact on Ghana's stock market and concluded that there's a connection between FDI, exchange rates, and stock market development, which indirectly implies financial influence on infrastructure.

Zhu's (2022) study investigated fiscal policy support for green finance and modern infrastructure development in China, indirectly revealing how a resilient domestic financial sector can drive infrastructural growth. Similarly, Ida, Assasie, and Boakye (2018) suggested that domestic financial development improves infrastructure outcomes, as local funds lead to eco-friendly infrastructure aligned with local needs. However, these studies didn't explicitly correlate financial development with infrastructure development. Ibrahim, Handoyo, Wasiaturrahma, and Sarmidi (2022) explored services trade's impact on infrastructure development across 38 African countries, uncovering various contributing factors. Li, Wang, Qi, and Zhang (2022) discussed China's financing of rural infrastructure through inclusive finance, highlighting the benefits of domestic financial strength for infrastructure projects. Both studies indirectly touched on the importance of financial development for infrastructure but didn't establish a direct correlation.

Examining Ghana's case, it's evident that a resilient domestic financial sector is vital for infrastructure development. The Ghana Infrastructure Plan (GIP) seeks massive financing, and the absence of a well-developed domestic financial sector often leads to overreliance on external sources. Ghana's debt burden from foreign financing hampers fiscal flexibility, limiting infrastructural expenditures. Research also shows that countries with robust financial sectors typically have better infrastructure. Therefore, it's essential to understand the causal relationship between financial development and infrastructure development for effective economic growth.

Furthermore, studies like Quartey (2005) and Ida et al. (2018) assessed the link between financial development, poverty reduction, and external inflows in Ghana. These studies touched on aspects of financial development's impact on infrastructure, but didn't establish a clear correlation. Ibrahim et al. (2020) investigated the relationship between services trade and infrastructure development in African countries, providing insights into trade's influence, but didn't directly tackle the financial development aspect. Li et al. (2022) focused on fiscal policy support for green finance development in China, indirectly highlighting the potential impact of a resilient financial sector on infrastructure.

The complex interplay between financial development and infrastructure was observed by Nafar (2019) and Zhou, Gao, and Chimhowu (2019), with the latter emphasizing that financial sectors mirror the strength of infrastructure. Developing countries often rely on external financing due to weak domestic financial systems, as seen in Ghana's case. The Ghana Infrastructure Plan (GIP) underscores the need for funds, relying heavily on external sources. However, external funding doesn't lead to robust financial development (Comes et al., 2018). Developing a robust financial sector is pivotal for economic growth (Xu et al., 2020), and China's well-developed financial sector was tied to infrastructure success

(Xu et al., 2020). Nonetheless, Ghana's financial sector remains underdeveloped, impacting its ability to support infrastructure projects.

Despite various studies examining financial development, human capital, and external financing's impacts on infrastructure development, none have explicitly explored the causal relationship between financial development and infrastructure in the context of Ghana. This gap underscores the necessity of this study to uncover the specific correlation between a well-developed domestic financial sector and infrastructure development in Ghana. The current research landscape reveals a need for more targeted investigations to establish this connection, taking into account Ghana's unique challenges and potential solutions to bridging the infrastructure deficit.

Moreover, financial development, among other things, has been identified as one of the building blocks of every nation. Finance forms the backbone of every country's economy (Nkemgha, Nchofoung, and Sundjo, 2022). According to the World Bank (2020), financial development has been the obstacle behind most countries' inability to realize economic growth. Financial development has, therefore, become the biggest obstacle to the development of most countries. There is a varying gap between financial development among countries and within countries across Africa. Some countries have well-coordinated financial sector to support their economies, while others have a greater financial development inadequacy (Ahmed, 2017). These financial sectors dictated by the capacity of the infrastructure to support the economy. Countries with a robust financial sector are built on a well-built infrastructure to support the economy (World Bank, 2017). Contrary to popular belief, a country with a weak financial sector develops a massive infrastructure deficit. Nafar (2019) opined that a country cannot fully function without a well-positioned infrastructure.

However, financial development can be built through domestic financing capacity of a county or from foreign sources. Foreign finances are often sought to finance domestic infrastructure when domestic finance is not well developed to support infrastructure development in the country. Financial development has been the anchor of domestic investment in various countries. Nafar (2019) established that the strength of finance has a direct impact on the quality of infrastructural development in a country. As a result, financial development is inextricably linked to infrastructure development amongst other things. Countries with weak financial development resort to foreign assistance to develop their infrastructure sector (Affum and Obiri, 2020). Esso (2010) opined that a well-developed financial system is fundamental to achieving viable and sustainable economic growth.

Most developing countries have weaker financial development modules to enable them to develop their infrastructure sector. Malick (2017) attributed the weaker financial development of developing countries to "slow economic growth, uncontrolled migration, climate change, and global unemployment," some of the world's major economic problems that will only be solved through Africa's economic prosperity. "Industrial development driven by infrastructure would alleviate the suffering of the people by reducing poverty" (Malick, 2017). This has been affirmed by the Affirmative Action for Women in Africa (AFAWA), which pegged the financing gap for women in Africa at around $42 billion, with $15.6 billion in the agricultural sector alone (AFAWA, 2020). Malick (2017) identified the factors that contribute to the country's poor financial development.

UNCTAD (2014) estimated $2.5 trillion annually as additional financing for developing countries across the globe to bridge the infrastructure development gap and succeed in building infrastructure for the realization of the SDGs' infrastructure. The widening infrastructure gap makes it difficult, if not impossible, to realize the MDGs in developing countries (UNCTAD, 2014). This case arises because most development partners expect a significant amount of the infrastructure funding to emerge from the domestic financial sector and investments. These may include public and private sector finance and investments. According to Dutta and Jeerh (2023), a portion of infrastructure financing is expected to be done domestically, and most developing countries' domestic financial sectors are underdeveloped to support the infrastructure drive required for economic growth. Because of their underdeveloped domestic financial sector and lackluster investment, developing countries have sought external financial assistance in the form of loans, grants, and foreign investments.

A well-built domestic financial sector allows countries to determine the exact infrastructure to invest funds in rather than relying on foreign funds or concessionary loans, which often come with preconditions and thereby restrict governments. Contrary to expectations, most developing countries are unable to raise enough resources domestically to support the infrastructure development in their countries due to external debt burdens, inadequate revenue mobilizations, innovative means of generating revenues, and weakened currencies. As a result, it triggered an over-reliance on foreign partners for the funds needed to support domestic infrastructure development. In 2014, the Organization for Economic Cooperation and Development (OECD) funded the Least Developed Countries with approximately $41 billion in ODA from OECD donor countries (OECD, 2015). Most of these projects do not yield revenue or are spent on social capital projects rather economic infrastructures. Developing countries have also relied on FDIs or Build, Operate, and Transfer (BOT), which cannot be relied on to fund large-scale infrastructure development required for development (Fosu and Aryeetey, 2008).

In their study of the Ugandan economy, Girma and Gong (2008) established a strong reliance of domestic infrastructure development on a resilient domestic financial sector. This has been the problem of most developing countries, including Ghana (GIP, 2021; World Bank, 2010). Most of the developing countries have not been able to develop a robust financial sector, which has an immense impact on infrastructure development. Comes et al. (2018) reiterated that most of the developing countries relied heavily on Foreign Direct Investment, grants, and loans to boost their financial sectors. In 2020, the government of Ghana spent over 21 billion drawn from government bonds on the clean-up of the banking sector (Gyimah-Brempong, and Nyoni, 2020). This activity was undertaken primarily to strengthen the domestic financial sector in order to provide alternative funding for government projects, primarily infrastructure. However, as a double-edged sword, bonds strengthen the financial sector in the short term while weakening it in the medium to long term (Esso, 2010) when the right financial mechanisms are not developed. Frimpong and Oteng-Abaye (2006) ascertained that foreign direct investment cannot be guaranteed to constantly flow into the economy and, as a result, are not a good financial tool to be relied upon for large-scale infrastructure projects hence the need to concentrate domestic finance development. The unreliability of the FDIs makes it difficult to sustain financial development in the country in most developing countries (Gyimah-Brempong and Nyoni, 2020).

Most of the infrastructure projects highlighted in Ghana's infrastructure development plan are earmarked for FDI financing. The infrastructure development plan has outlined some of the government's priority areas. However, this dwells on the availability of funds (Mante, 2020). The reliance on loans and grants for infrastructural development has resulted in a huge infrastructural deficit in the country. According to Vivien and Nataliya (2011), this massive infrastructure deficit is the result of poor financial development. Building a stronger financial system in Ghana relied on the presence of robust infrastructure (AICD, 2011). Ghana spends about $1.2 billion annually on infrastructure, equivalent to 7.5% of Gross Domestic product (GDP) (AICD, 2011). The infrastructure plan, however, did not stipulate funding alternatives for the various infrastructures earmarked to be financed by FDIs or BOT if the funding sources failed within the period. Nonetheless, Comes et al. (2018) opined that Foreign Direct Investment weakens domestic financial development.

The Africa Infrastructure Country Diagnosis (AICD) opined in 2010 that the housing deficit in Ghana has resulted from the inability to build a robust domestic financial sector that can support infrastructure development (AICD, 2010). A well-developed financial sector serves as a conduit for the development of infrastructure. It enables the country to undertake sustainable, large-scale infrastructure development without external support. Affum and Obiri (2020) asserted that the banking clean-up in Ghana was meant to enhance the financial sector to support the government's infrastructure drive. The Bank of Ghana (2019) characterized its operation as strengthening the financial sector and protecting depositors' funds in the long run. However, Ghana Business News (2020) reported that it was an operation carried out by the government to ensure that long-term deposits and funds are accessible by the government to execute its flagship projects, which included infrastructure. Ofori-Atta (2020) concluded that the financial sector is grounded to undertake infrastructural developments to meet the needs of the country.

According to Nafar (2019), the world needs to develop a deliberate financial plan for the development of infrastructure in various countries. Moreover, the financial development module has to be inculcated in various countries needing infrastructural development. This will ensure available funds in the domestic financial market for the government to undertake infrastructural development in the country. Baltagi, Demetriades, and Law (2007) researched financial development in various economies using annual reported data to establish a correlation between foreign trade and external flow and the development of the domestic finance sector. The findings indicated that opening up trade and financial flow in and out of the country aids in financial development. The study also opined that opened economies have the potential to develop a more robust financial sector than closed economies.

Over the last ten years, annual infrastructure financing in Ghana has increased by 208% (GIP, 2021) where majority of the funds are sourced externally. Since 2007, Ghana has invested $23 billion in infrastructure development mainly through loans, bonds, and grants (GIP, 2021). Ghana's Infrastructure Plan (GIP) sets the benchmark for the attainment of the post-2015 development agenda and Sustainable Development Goals (SDGs). The GIP aims to build world-class, resilient infrastructure assets to support Ghana's continued growth and to improve the quality of life of all Ghanaians by 2047 (GIP, 2021). However, financing these projects has always been a concern for the country, as most of the funds are borrowed from external sources for these large-scale infrastructural projects. These loans for the infrastructural projects become a debt burden on the country’s financial management, limiting the fiscal space and tightening government infrastructural expenditures. The country's debt burden is growing as the government continues to borrow externally for infrastructure projects (Ahmed, 2017). External loans, grants, and FDI weaken domestic financial development (Comes et al., 2018). Because the domestic financial sector is not well developed to support infrastructure development, these external financing methods have become the primary means of financing infrastructure development in the country. Domestic finance was used to develop infrastructure in countries with a well-developed finance sector.

This makes financial development a major talking point across the globe. Countries have designated finance and development as priority areas in order to gain access to funds for development projects. Ghana’s financial sector has been developing over the past decades. The liberalization of the financial sector paved the way for financial development in the country. However, the financial sector has also witnessed several turbulences over the past decades, which includes the banking sector clean up in 2019 (Mante, 2020). The clean-up was carried out to ensure robust financial development in the country. Ncanywa and Mabusela (2019) posited that financial development has been characterized by improving businesses and financial policies. These policies ensure the rapid development of the financial sector (Kwakye, 2012). The inability of the domestic financial sector to generate enough financing for development leads to the country’s reliance on foreign direct investments, grants, external loans, and support for domestic investments. These external tools relied on by countries for domestic investment have also been a hindering factor for domestic financial development (IMF, 2020).

This study has become necessary because some studies have been conducted on the financial development of Ghana, including its impact on infrastructure development. Ghana’s banking sector cleanup was one of many financial development policies implemented to strengthen the financial sector. However, the Auditor General's Report outlined various uncompleted infrastructures in the country as resulting from funding gap (Auditor General Report, 2021). As a result, this study looked into the impact of domestic financial development on Ghana's infrastructure development. It also delves into the synergy between financial development and infrastructure development, the level of influence of a well-developed financial sector on the development of infrastructure in Ghana, and particularly identifies the various financial modules that are most influential in the development of infrastructure.

### 2.3.2 Neutral link

Frimpong, Akwaa-Sekyi, Sackey, and Sole (2022) undertook a study using the diversification theory to explore the relationship between financial development and infrastructure development in Ghana. The diversification theory, often used to study venture capital fundraising, was employed to identify sources of venture capital funding and equity risk capital fundraising. While the theory provides a broad perspective on financing, it didn't align well with the study's specific focus on domestic financial sector funds for infrastructure (Rahman et al., 2021). Although the theory allows for the inclusion of internal and external flows and the examination of various thematic areas such as infrastructure and economic growth, it wasn't the ideal fit for directly assessing the link between financial development and infrastructure development in Ghana.

In contrast, Frimpong and Oteng-Abayie (2013) utilized bivariate causality in their study to establish a connection between foreign direct investment (FDI) and GDP growth in Ghana. By employing the Granger causality test along with the Toda-Yamamoto Granger causality test, they aimed to strengthen the data collection and testing process. Their findings indicated no general causality between FDI and GDP growth from 1970 to 2002, suggesting that FDI didn't significantly contribute to economic growth during that period. This aligns with Esso's (2010) assertion that FDI can weaken financial development if it doesn't lead to economic growth. Odhiambo (2009) further supports this view, emphasizing the negative impact of FDIs on the financial sector. Despite the complexity of theoretical frameworks used, bivariate causality provided a robust means to directly test the causal relationship between financial development and infrastructure development within the study's scope.

Agyapong, Asiamah, and Crabbe (2019) explored the influence of capital inflows on Ghana's domestic financial development using the Johansen and Juselius multivariate co-integration approach. Their investigation revealed that foreign direct investment (FDI), external debt, and remittances had a negative impact on the development of Ghana's banking system. This aligns with the research conclusion of Malick (2017), who highlighted the detrimental effect of external capital flows on domestic financial development. In many developing countries, including Ghana, the reliance on external loans and FDIs has weakened the domestic financial sector (Affum and Obiri, 2020). This over-reliance on external capital sources, as outlined in Ghana's Infrastructure Development Plan (GIP), poses challenges due to their unreliability (Malick, 2017). This study's significance lies in its exploration of how a well-developed financial sector impacts Ghana's infrastructure development.

In the context of financial development and infrastructural development, many developing countries, including Ghana, grapple with insufficient financial development frameworks. Malick (2017) linked the inferior financial development of poor countries to various global financial issues and stressed the role of infrastructure-driven industrial growth in alleviating poverty. The Affirmative Action for Women in Africa (AFAWA) highlighted a significant finance gap for women in Africa's agriculture sector, emphasizing the financial challenges faced by the region (AFAWA, 2020). These variables contribute to the financial underdevelopment observed in the country (Malick, 2017).

### 2.3.3 Weak link

Iva Sojková's (2017) investigation delved into the characteristics of China's official development finance assistance to Ghana within the 2000-2013 timeframe. The findings highlighted China's role as an alternative source of financial assistance for many African developing countries, including Ghana, to bolster both their financial sectors and infrastructure projects. China's financial assistance spans a spectrum from large-scale infrastructure investments to smaller water projects (Kang et al., 2022). Despite data scarcity from unofficial sources, Sojková (2017) relied on media and government outlets for information on China's financial aid. Notably, China's financial procedures diverge from international norms (Kang et al., 2022), and instances such as the Sinohydro agreement with Ghana, involving bauxite mining, exemplify unique financial arrangements (Asamoah and Botchway, 2021).

Takyi and Obeng (2013) explored determinants of financial development in Ghana. Their ARDL approach revealed trade openness and per capita income as key drivers, while inflation, interest rates, and reserve requirements negatively influenced financial development. Surprisingly, government borrowing showed no significant short- or long-term impact, indicating the need for domestic capital accumulation for borrowing purposes. Despite the study's focus on different factors, it pointed out the importance of infrastructure development as a catalyst for government borrowing. Infrastructure projects, prioritized for economic growth, emerged as the dominant government expenditure (Kuete and Asongu, 2021). However, this borrowing spree weakened the link between financial development and infrastructure spending (ECA, 2017), necessitating a correlation between government access to funds and infrastructure projects.

Frimpong and Oteng-Abayie (2006) explored foreign investment inflows and economic growth in Ghana, using bivariate causality to establish a lack of causal relationship between foreign investments and GDP growth. Building on this theoretical framework, Frimpong, Akwaa-Sekyi, Sackey, and Sole (2022) extended their study to Spain's financial sector. They stressed the interdependence of financial sectors' components and the importance of financial stability for overall development. Accumulated capital, whether from internal or external sources, plays a key role in infrastructure development and economic growth. Frimpong and Oteng-Abayie (2006) applied bivariate causality in their research on foreign investment inflows and economic growth in Ghana, providing a framework for studying financial and economic relationships. This framework, adopted for studying the link between financial and infrastructure development, demonstrated its applicability across variable contexts. In the context of Spain, Frimpong et al. (2022) found that disturbances in any part of the financial sector impact the entire sector's stability, demonstrating the interconnectivity of financial components. Capital accumulation through innovative means like venture capital aids both financial development and government access to infrastructure funds (Azolibe and Okonkwo, 2020).

Global competition in the domestic financial sector has been observed (Kang et al., 2022), sometimes leading to the exit of venture capitalists and potential repercussions for financial systems. Kang et al. (2022) discussed the global competition shaping domestic financial sectors, enabling easier exits for firms with concentrated venture capital. Such dynamics can disrupt financial sectors, as seen with Barclays Bank Africa's exit from African markets (Rahman et al., 2021). Foreign-sourced venture capital can also be withdrawn unexpectedly, affecting developing countries with volatile financial systems. Despite these challenges, many countries, including Ghana, aspire to build their domestic financial sectors for capital accumulation, essential for infrastructure and economic growth (Rehman et al., 2020). Efforts to develop the financial sector resonate across countries, with the aim of fostering capital accumulation for economic growth (Asteriou and Spanos, 2019). The linkage between financial development and infrastructure development is intricate, with one often influencing the other.

Ma and Lin (2016) noted significant financial sector growth in recent decades, following periods of hiatus. Structural changes, as part of Ghana's Economic Recovery Program, aimed to revive the economy through financial sector reforms. Yet, despite financial development, the translation into infrastructure development has not always materialized (Dinika et al., 2022). Ghana's efforts to stimulate both financial and economic growth through financial sector clean-up underscore the complex relationship between financial development and infrastructure enhancement. Torun and Aslan (2022) explored financial development trends through bibliometric analysis, underlining growing interest in the topic among scholars. This heightened focus aligns with efforts to create resilient financial systems for capital formation and economic growth (Asteriou and Spanos, 2019). However, economic growth hinges on coordinated infrastructure development, leading to the inquiry into the relationship between financial and infrastructure development.

Ruiwei Zhu (2022) highlighted the growing importance of green finance to counter climate challenges. While advocating financial development, countries are also urged to focus on green economic growth and sustainable infrastructure. Zhu's study emphasized government responsibility in green finance, which could impact both the financial sector and infrastructure development. This emphasizes the need for environmentally conscious financial development. Ghana's financial sector, despite its recent clean-up efforts, remains in flux (Mante, 2020). The country's dependence on external funding sources for development projects reveals a gap in domestic financial development (IMF, 2020). Ncanywa and Mabusela (2019) underscore the significance of business improvement and policy enhancement in this context. The intricate interplay between financial development, infrastructure enhancement, and economic growth underscores the multifaceted nature of these domains.

Again, financial development in Ghana has been one of the biggest challenges in the last decade. The country’s domestic financial market has been poorly developed to support the government’s infrastructure development (Gyimah-Brempong, and Nyoni, 2020). The Auditor General’s report (2019) recounted the unavailability of funds to fully finance infrastructure that has been initiated. This often leads uncompleted projects or delayed its completion schedule has causes financial losses to the state. The inadequacy often resulted from lack of ready funds within the country to finance these projects initiated. Also, delay in project completion often leads to project reevaluations and sometimes re-awarding of contracts, which increases the cost of delivery from the original cost. This unmerited cost results from the unavailability of project finance. Project finance also results in scheduling difficulties in project execution. These projects add additional costs to the initial cost of the project due to the unavailability of domestic financing sources. It has been established that government have always relied on external funding sources rather than domestic, hence the poorly development of the financial sector (Gyimah-Brempong, and Nyoni, 2020).

Furthermore, weakening of the financial sector leads to a financial crisis for both domestic and external creditors (Azeez et al, 2015). According to Gockel (2020), the financial challenges, that has been be described as a "credit crunch", takes place in an "uncontrollable reduction in money supply and wealth," leading to loss of confidence and people refusing to honor their debt obligations. A well-developed domestic financial sector does not only help the government access funds for infrastructure development but also gives confidence to foreign direct investments, which the Ghana Infrastructure Plan (GIP) relies on to bridge the infrastructure deficit (GIP, 2021). Ghana's quest to bridge the infrastructure deficit led to the infrastructure plan. However, the plan has not established the relationship between domestic financing and infrastructure development. This has often been overshadowed by external loans, and grants in the process of infrastructure development. As a result, the purpose of this research is to determine the relationship that exists between developing a well-developed domestic financial sector and infrastructure development in Ghana. There is the need for this study to establish the relationship between the domestic financial sector and developing infrastructure.

Some studies have been conducted on this subject area includes Nkemgha et al. (2022), who have conducted research on this subject using Africa as the setting. Among other things, the study concentrated on social, capital, and soft infrastructure development in Africa. The study, however, was unable to distinguish between African countries with robust infrastructure as a result of a well-developed financial sector and those with a weakened financial sector, resulting in an infrastructure deficit. The lumping of the whole Africa as a unit makes it difficult to appropriate individual's country's financial sector contributions towards their infrastructure development. There was also a challenge in accessing comprehensive data from official sources for this study to fully understand the variables under study.

Nkemgha et al. (2022) therefore recommended that future research on the subject be carried out at various country levels for better understanding of the relationship between financial sector development and infrastructure development. Moreover, Ghana financial sector has been unstable between 2017 and 2023 leading to banking sector clean up within the period, domestic debt exchange program and other activities geared towards strengthening the financial sector in Ghana. The instability in the financial sector posed a challenge to all sectors of the economy including infrastructure development. As a result, this study included a country-level analysis to determine the causal relationship between financial development and infrastructure development in Ghana.

## 2.4 Chapter summary

In accordance with the study's requirements, the chapter defined the various concepts. The concepts included financial development, infrastructure development, and financial infrastructure. Nonetheless, the review focuses on financial development as the independent variable, while infrastructure development is the dependent variable in this study. Various empirical studies were reviewed within the context of financial development and infrastructure development. The strengths, weaknesses, and applicability of the study to the current study have been highlighted in the content of this chapter. The review also spanned global and continental issues and narrowed down to the situation in Ghana. This lays the foundation and is forecasted into the next chapter, where the data collection methods and techniques are highlighted while offering the data analysis procedure.

# CHAPTER THREE

# METHODOLOGY

## 3.0 Overview

This chapter consists of the methods and processes of the study. The research methods are procedures and techniques that guide the collection of data and analysis of same to draw a conclusion on the variables tested. It is regarded as the engine or the pivot around which the research revolves. The chapter highlighted the research design and methods. It highlighted the type and nature of data collected, tools for data analysis, and presentation of the results. Moreover, methods of data validity and reliability are considered in this chapter.

## 3.1 Research paradigm

According to Asamoah (2015), a research paradigm is made up of world views and assumptions that serve as the framework for a study. The post-positivist paradigm served as the guiding framework for this study. The postpositivist paradigm, as defined by Creswell and Creswell (2018), is the typical form of study represented by postpositivist principles. This is more true of quantitative research than of qualitative research. This viewpoint is sometimes referred to as the scientific process or the process of performing scientific inquiry. It is also referred to as positivist/postpositivist research, a science that is empirical, and empirical investigation.

This final terminology is post-positivism since it reflects the philosophy that followed positivism, which challenges the conventional view of the complete truth in understanding (Phillips and Burbules, 2000) and recognizes that when investigating human conduct and actions, one can't be completely certain about comprehension claims. Postpositivist authors from the nineteenth century include Comte, Mill, Durkheim, Newton, and Locke, as well as Phillips and Burbules more recently (Phillips and Burbules, 2000).

Postpositivist knowledge is founded on meticulous observation and measurement of objective reality "out there" in the world. As a result, a postpositivist must establish numerical measures of observations and examine individual behavior. Finally, laws or hypotheses that control the world must be tested, verified, and validated improved such that we can grasp it (Creswell and Creswell, 2018). Thus, in the scientific method, which is the acknowledged approach to study among postpositivists, a researcher starts with a hypothesis, collects data that either supports or refutes the theory, and then revises and tests the theory, as this investigation has done.

## 3.2 Research design

The study's technique was quantitative research design. Quantitative data is evidence that is composed of numbers and figures which has been tested, gathered, recorded, assessed, and presented via visuals such as charts and graphs or alternative statistical techniques that include statistical methods (Asamoah, 2015). Fundamentally, the research deals with mathematical and statistical models and data of financial development and infrastructure development. These models allows for the synchronization of these data using time series model spanning a 30 year period from 1990 to 2020. This model also allows for the analyses of a chosen sample over many years. It also allows for the detection of causal relationships (cause and effect) and parallel relationship which the time series data is the most useful method as compared to the alternative, the cross sectional data which deals with a single year data with multiple variables. However, they are all used for testing for causal relationships.

### 3.3 Data sources

The study relied on secondary source for data collection hence the use of secondary data. The secondary quantitative data includes the various categories of financial development and infrastructural development which are all collected from the websites of official government sources such as the International Monetary Fund (IMF), and African Development Bank (AfDB). The data components are presented in table (1) below;

**Table 1 Distribution of Data Sources**

| Variable | Measurement | Data Source | Frequency |
| --- | --- | --- | --- |
| Banking Sector | Financial Development Index | International Monetary Fund | Annual |
| Insurance Sector | Financial Development Index | International Monetary Fund | Annual |
| Capital Market | International Monetary Fund | International Monetary Fund | Annual |
| Finance Houses | International Monetary Fund | International Monetary Fund | Annual |
| Transport Sector | Infrastructure Development Index | African Development Bank | Annual |
| Energy Sector | Infrastructure Development Index | African Development Bank | Annual |
| Communication | Infrastructure Development Index | African Development Bank | Annual |
| Economic Growth | Gross Domestic Product annual percentage of Growth | World Bank | Annual |

The data are all annual time-series data spanning the period 1990–2020. These periods are particularly important due to the number of economic reforms adopted to boost the economic growth at various stages of the study period. These various components of financial development and infrastructure development data are synchronized into the annual accumulated averages to allow for the mathematical formulations to be used in evaluating the variables using the time series.

### 3.3.1 Variables and Measurement

Infrastructure development serves as the dependent variable in the study, it is measured by the infrastructure development index (IDI) computed by the African development bank, this index comprises of the annual averages of some selected infrastructure development components which includes the energy sector, communication sector, transport sector and rural sector.

Financial development serves as the independent variable in the study, it is measured by the financial development index (FDI) computed by the International Monetary Fund, it comprises of the annual averages of some selected infrastructure development components which includes the banking sector, insurance sector, capital markets and finance houses.

Economic growth also serves as the control variable in the study. It is proxy by gross domestic product as annual percentage of growth. The economic growth rate variable is represented by Y, its computation was drawn from World Bank database for this analysis.

### 3.4 Software: Econometric Views (EViews)

E-views is a statistical package used in the analysis of econometric and economic data. It strength lies in time series, general statistical analysis and econometric analyses, such as cross-section and panel data analysis. It helps breakdown diverse data in simple estimates for easy analysis and forecasting.

**Hypotheses**

The null hypothesis ($H_0$) and alternative hypothesis ($H_1$) of the significance test for correlation can be expressed in the following ways, depending on whether a one-tailed or two-tailed test is requested:

$H_0$: $\rho = 0$ ("the population correlation coefficient is 0; there is no association")

$H_1$: $\rho > 0$ ("the population correlation coefficient is greater than 0; a positive correlation could exist")

OR

$H_1$: $\rho < 0$ ("the population correlation coefficient is less than 0; a negative correlation could exist") where $\rho$ is the population correlation coefficient.

### 3.5 Model Specification

Th model below has been adopted from Khan and Senhadji, (2000), Christopoulos and Tsionas, (2004), and Asamoah and Botchway (2021) on financial development and economic growth which has been modified to test financial development and infrastructure development in this enquiry. The equation blow is estimated using the Fully Modified

Ordinary Least Squares (FMOLS) to critical examine the relationship between the dependent and independent variable. This equation is illustrated below:

$$IDI = \beta_0 + \beta_i \sum_{i=1}^{m} Y_t + \beta_k \sum_{k=1}^{n} FDI_t + \varepsilon_{1t} \ldots\ldots\ldots\ldots equation\ 1$$

The equation is considered to be long-run or equilibrium relation.

Where: $t$ represents the year,

IDI represent infrastructure development (measured by infrastructure development index IDI)-Dependent variable

FDI represent financial development (measured by financial development index FDI)-Independent Variable

Y represent economic growth rate as control variable (measured by gross domestic product annual percent growth Y) - Control variable

Ɛ represent the error term.

$\beta_i \ldots \beta_m$ represent slope parameters for the control variables $Y_t$

$\beta_k \ldots \beta_n$ represent slope coefficients for the Financial Development Variables $FDI_t$

**3.6 Data analysis techniques**

Descriptive statistics were used in the data analysis for this investigation. Mean, Median, Maximum and Minimum values, standard deviation, Skewness, The Kurtosis Jarque-Bera statistic and its probability value, Sum of data observations, Sum Squared Deviations, and total number of Observations are used to illustrate the data set for all variables.

### 3.7 Unit root test

Individual Unit Root Checks were done on the data series following the discovery of the fundamental trend underlying each variable sequence using any of the three Augmented Dickey-Fuller (ADF) test models that are compatible with the trend lines observed on each variable. The time series properties of the variables were investigated using the unit root tests of the Augmented Dickey-Fuller and the Phillip Perron and Johansen Co-integration Tests. The Augmented Dickey-Fuller, Phillip Perron, and Johansen Co-integration Test are used as a stopgap because bivariate causality analysis excludes some other relevant variables such as capital, credit ratings, and inflation effects that could have a significant relationship with the two variables in question. As a result, the investigation revealed numerous empirical studies that improved the financial development relationship by integrating one or more key macroeconomic factors in their models (Nickell, 1981). Bajwa and Siddiqi (2011), for example, give a study that investigates the relationship between economic growth, openness, labor force, and gross fixed capital formation. Inflation (Nkoa, 2016), foreign direct investment (Totouom et al., 2019), investment and government spending (Ndikumana, 2003), and other variables are studied in other studies. As a result, in the instance of Sri Lanka, removing capital, labor, and inflation, for example, could severely skew empirical causation conclusions between trade openness and economic growth, because these three variables are important disbursement items.

The three equations of the ADF test is highlighted below:

$$\Delta Y_t = \beta_1 + \varphi\, Y_{t-1} + \alpha_1 + \epsilon_t \quad \text{………………….equation 2}$$

$$\Delta Y_t = \beta_1 + \beta_2 t + \varphi\, Y_{t-1} + \alpha_1 + \epsilon_t \quad \text{…………..equation 3}$$

$$\Delta Y_t = \varphi\, Y_{t-1} + \alpha_1 + \epsilon_t \quad \text{…………………………equation 4}$$

The above are the fundamentals of ADF equations where equation (2) represents Intercepts only, equation (3) represents Trend and Intercept Only and equation (4) represent No Trend, No Intercept. However, these projections are obtained using a visual study of the data series' numerous trend lines. The Augmented Dickey-Fuller and Philip Perron Tests were used to analyze all of the individual analyses.

The ADF test involves estimating Hamilton's (1994) equation:

$$\Delta Y_t = \alpha + \beta t + p y_{t-1} + \sum_{j=1}^{k} Y\ _j \Delta Y_{t-j} + \varepsilon_t; t = 1, \dots \dots, T \dots\dots \text{ equation 5}$$

Therefore; T is the sample length, t is trend time, and k is lag of dependent variable length. These parameters are done through a modified Akaike Information Criterion (AIC) (Ng and Perron, 2001). The ADF determines the level of variable integration and whether the data series observed are stable.

The Augmented Dickey-Fuller (ADF) test values are similar to Phillips-Perron (PP) tests (Asamoah and Botchway, 2021). Purposely used in understanding how the ADF test for autocorrelation between error terms adopts non-parametric approaches especially those outside the regression trends (Amaral, Corbae, & Quintin, 2017). Coincidentally, the vital values for the PP tests also follow similar trends as the Augmented Dickey-Fuller statistic (Durusu-Ciftci, Ispir, and Yetkiner, 2017). The ADF tests' lag lengths are obtained automatically from the Schwarz Information Criterion (SIC) (Asamoah and Botchway, 2021). The spectral estimate approach for the PP tests is based on the Bartlett kernel to allow for residual correlation, the bandwidth of which is predetermined primarily on the Newey-West bandwidth. (Nkemgha, Nchofoung and Sundjo, 2023).

### 3.8 Cointegration tests:

### 3.8.1 Johansen system cointegration tests

In case there is any existence of a unit roots test or non-stationary established by the ADF or PP model, it will suggest the performance of the cointegration tests to examine whether there is a long-term relationship between the variables of interest which happens to be financial development and infrastructure development.

Vector autoregression model:

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + Bx_t + \epsilon_1 \dots\dots\dots\dots \text{equation } 11$$

Therefore $y_t$ is a $k\text{−}vector$ of non-stationary I (1) variables, $x_t$ is a $d\text{−}vector$ of deterministic variables, and $\epsilon_1$ is a vector of innovations.

This Vector Autoregression may be rewritten in the following format:

$$\Delta y_t = \Pi y_{t-1} + \sum_{1=1}^{p-1} \Gamma\ _i \Delta y_{t-i} + Bx_t + \epsilon_1 \dots\dots.\ equation\ 12$$

Where:

$$\prod = \sum_{i=1}^{p} A_1 - I,\ \ \Gamma_i = - \sum_{j=i+1}^{p} \ \dots\dots\dots\dots\dots equation\ 13$$

The Granger's representation theorem postulates that if the coefficient matrix Π=$\alpha\beta'$ and $\beta' yt$ is I (0). $r$ is the number of cointegrating relations (the cointegrating rank) and each column of $\beta$ is the cointegrating vector and the elements of $\alpha$ are known as the adjustment parameters in the Vector Error Correction (VEC) model (Hamilton, 1994; Johansen 1995). Johansen's method is to estimate the Π matrix from an unrestricted VAR to test whether to reject the restrictions implied by the reduced rank Π (Johansen, 1991; Bist and Read, 2018; Asamoah and Botchway, 2021).

**Economic Model for examining the relationships between financial development and infrastructure development in Ghana.**

### 3.9The simple granger bivariate-causality tests

The study adopted the Simple Granger Bivariate Causality Test to explore the outcome of the dependent variable which is explainable from the independent variable using asymmetric analysis. The Simple Granger Correlation therefore experiment the relationship between two variables on a cause-and-effect relationship (symmetrical analysis). The study introduces the concept of causation or independent (Financial development) and dependent or explanatory variable (infrastructural development). Also, some statistical techniques used for the analysis of the relationship between the two variables will be presented, based on the type of variable; either categorical or continuous.

Hence, the simple pairwise Granger-causality test is used to ascertain the direction of causality between Infrastructural development and financial development. For two variables y and x, the Granger-causality test requires the following regression as estimated below estimated:

$$y_t = \alpha_0 + \sum_{i=1}^{m} \alpha_0 \, x_{t-1} + \sum_{i=1}^{m} \beta_0 \, y_{t-1} + u_{1t} \dots \dots \dots \dots \dots equation\ 6$$

$$x_t = \beta_0 + \sum_{i=1}^{m} \lambda_1 \, y_{t-1} + \sum_{i=1}^{m} \delta_1 \, x_{t-1} + u_{2t} \dots \dots \dots \dots \dots . . equation\ 7$$

Where: $Y_t$ represents the data series for the dependent variable at time t (Infrastructure development) and $X_t$ represents the values of the independent (Financial development) and control variables at a time, *t*. Generally, if *x* significantly impacts *y*, then *x* Granger causes *y*, and the changes in *x* always precede changes in *y*. The inclusion of the past or lagged values of *x (*i.e. $x_{t-1}$ and$x_{t-i}$) and *y (i.e.,* $y_{t-1}$  $y_{t-i}$) significantly enhances the explanatory power of the regression model. However, whether or not there is Granger-causality between financial development and infrastructure development has been ascertained using the F test. The calculated F-value is attained by the following:

$$F = (n-k)\frac{RSS_R - RSS_{UR}}{m(RSS_{UR})} \dots \dots \dots equation\ 8$$

Where:

$RSS_R - RSS_{UR}$= consecutive values are the Residual Sum of Squares in the restricted and unrestricted equation. Also, n= number of observations; m= number of lags; k= the number of variables estimated in the unrestricted equation.

At the end of the test, if the F-values and the P-values are smaller than the crucial values of 0.05 or 0.10, it insinuates a unidirectional or bi-directional causality between finance and infrastructure development (Olaniran, 2018). The lag selection is done using Schwarz Information Criteria (SIC) outlined earlier.

**Economic models for examining short and long-term relationship between financial development and infrastructure development.**

**3.10 The fully modified ordinary least squares (FMOLS)**

For further understanding of the long-run relationship between the dependent and the independent variable, the dimensional time-series vector process, ($y_t$, $X_t{}'$) with cointegrating equation is highlighted below:

$$y_t = X_t'\beta + D_{1t}{}'^{\Upsilon_1} + \mathrm{u}_{1t} \dots \dots .. equation\ 14$$

**Where:** $D_t$= ($D_{1t}{}'$, $D_{2t}{}'$) were deterministic trend regressors and the stochastic regressors were governed by the system of equations:

$$X_t = \Gamma_{21} D_{1t} + \Gamma_{22} D_{2t} + \varepsilon_{2t} \dots \dots \dots \dots .. equatioon\ 15$$

Where: $\varepsilon_{2t} = \mathrm{u}_{2t}$

Phillips and Hansen (1990) leverage the problem of cointegrating equations and stochastic regressors to suggest a semi-parametric approach that eliminates the problem created by the longer-term interaction. A fully modified Ordinary Least Squares (OLS) (FMOLS) method, on the other hand, is asymptotically unbiased and has completely successful pairs of frequent asymptotic that provide identical pattern tests with asymptotic statistical inference from Chi-square (Hansen, 1994). In the FMOLS prediction model, the symmetric and single-sided residual covariance matrix elements are approximation forecasts (Asamoah and Botchway, 2021; Hansen, 1994). This change has been highlighted below;

Let $\hat{\mathrm{U}}_{1t}$ be the residuals derived after modifying be Equation (16). Then, $\hat{\mathrm{U}}_{2t}$ was obtained indirectly as $\hat{\mathrm{U}}_{2t} = \Delta\varepsilon_{2t}$ from the levels regressions.

$$X_t = \Gamma_{21}D_{1t} + \Gamma_{22}D_{2t} + \varepsilon_{2t} \dots\dots\dots\dots. equation\ 16$$

Or this can also be obtained directly from the difference of regression stated below:

$$\Delta X_t = \acute{\Gamma}_{21''}\Delta D_{1t} + \acute{\Gamma}_{22'}\Delta D_{2t} + \hat{U}_{2t} \dots\dots\dots. equation\ 17$$

Now, after obtaining the residuals above, the long-haul covariance matrices were processed using the residuals $\hat{u}_t = (\hat{u}_{1t,}\ \hat{u}_{2t,})$. Consequently, the data can be modified as:

$$y_t{}^{+} = y_t - \acute{\omega}_{12}{}'\Omega_{22}{}^{-1}\hat{U}_2 \dots\dots\dots\dots. \text{equation } 18$$

Equation (18) becomes the estimated bias correcting equation (19).

$$\lambda_{12}{}^{+} = \lambda_{12} - \acute{\omega}_{12}{}'\Omega_{22}{}^{-1}\hat{U}_2 \dots\dots\dots\dots \text{equation } 19$$

Then, the FMOLS estimator as given below can used:

$$\theta = \begin{bmatrix} \beta \\ \gamma_1 \end{bmatrix} = \left(\sum_{t=2}^{T} z_t z_t\right)^{-1} \left(\sum_{t=2}^{T} z_t y_t{}^{+} - T\begin{bmatrix} \lambda_{12}{}^{+} \\ 0 \end{bmatrix}\right) \dots\dots\dots\dots \text{equation } 20$$

Therefore; $Z_t = (X_t', D_t{}')$

However, according to Asamoah and Botchway (2021), the methodology of FMOLS computation is development of long-haul covariance matrix estimator $\hat{\Omega}$ and $\hat{\Lambda}$. Then, the possible options for measuring $\hat{\Omega}$ and $\hat{\Lambda}$, the scalar estimator can be discussed as:

$$\hat{\omega}_{1.2} = \hat{\omega}_{11} - \widehat{\omega}_{12}\widehat{\omega}_{22}{}^{-1}\widehat{\omega}_{21} \dots\dots\dots\dots. equation\ 21$$

The expected long-haul variance of $u_{1t}$ is conditional on the variance$u_{2t}$. Nonetheless, a degree of freedom correction can be added to $\hat{\omega}_{1.2}$ to synchronize the variance. Hansen (1992) depicted the Wald statistic of the null hypothesis Rθ=r and this is depicted below:

$$W = (R\hat{\theta} - r)'(RV(\hat{\theta})R)^{-1}(R\hat{\theta} - r) \ldots \ldots \ldots \ldots \text{equation } 22$$

With,

$$V\theta = \hat{\omega}_{1.2}\left(\sum_{t=2}^{T} Z_t Z_t'\right)^{-1} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \mathit{equation}\ 23$$

**3.10.1 Checking the robustness of the FMOLs estimates**

The Canonical Cointegration Regression (CCR) model is used to test the robustness of the findings in terms of statistical significance consistency and parameter estimations (Reid, 2010; Park, 1992). When cointegrated, the Ordinary Least Squares (static OLS) estimation of the cointegrating vector is universally recognized and congregates faster than the norms (Hamilton, 1994). The asymptotic features of projections, which often include non-Gaussian asymmetry, asymptotic bias, and non-scalar difficulties, are a significant constraint of Static OLS (SOLS) (Asamoah and Botchway, 2021). This is primarily due to orthodox research methodologies, which are extremely disputable until significant changes are made (POV, 2017). If an inference is performed on the cointegrating vector, SOLS is often not supported (Park, 1992).

Tarihi and Tarihi (2019) opined that SOLS's panicking asymptotic distribution occurs due to the long-term collaboration between regressors and equation errors, as well as a cross-relationship between equations and regressors. Saikkonen (1992) and Stock and Watson (1993) introduced a straightforward approach for an asymptotically estimator augmenting

SOLS cointegrating process. The Canonical Cointegrating Regression (CCR) model effectively handles the issues discussed earlier in this section when applied to the SOLS model hence the challenges emanating from the SOLS model can be checked by CCR model (Asamoah and Botchway, 2021; Nkamgha, Nchofoun and Sondju, 2023). The CCR is closely interlinked to FMOLS (Park, 1992). The difference between them is the CCR used Stationary transformations of $(\boldsymbol{y_{1t}}, \boldsymbol{X'_t})$ data to the least squares projections to remove the long run dependence between the cointegrating equation and stochastic regressors innovations (Trew, 2006). Like the FMOLS, CCR projection follow a mixture of normal distribution that is free of non-scalar unstable parameters and permits asymptotic Chi-square testing (Park, 1992). The following Λ columns corresponding to the one sided long-run covariance matrix of $U_t$and lag levels of$U_{2t}$.

$$\Lambda_2 = \begin{bmatrix} \lambda_{12} \\ \Lambda_{22} \end{bmatrix} \dots\dots\dots\dots equation\ 24$$

To further understand this robustness of the figures, equation (24) has been transformed $(\boldsymbol{y_{1t}}, \boldsymbol{X'_t})$ using the following equations:

$$X_i = X_i - (\sum\nolimits^{-1} \lambda_2)' U_t \dots\dots\dots\dots\dots..equation\ 25$$

$$y_i = y_i - \left(\sum\nolimits^{-1} \lambda_2 \beta + \begin{bmatrix} 0 \\ {\Omega_{22}}^{-1} \omega_{21} \end{bmatrix}\right) U_t \dots\dots\dots.equation\ 26$$

Where $\beta$ are assumptions of the cointegrating equation coefficients, the SOLS projections are normally used to acquire the residuals$U_{t1}$. However, the CCR projector explains the ordinary least squares used in the transformed data as:

$$\begin{bmatrix} \beta \\ \gamma_1 \end{bmatrix} = \left( \sum_{i=1}^{T} Z_t{}^* Z_t{}^{*\prime} \right)^{-1} \sum_{t=1}^{T} Z_t{}^* y^* \dots \dots \dots \dots \dots \dots equation\ 27$$

Where; $Z_t{}^* = (Z_t{}^{*\prime}, D_t{}^{*\prime})'$

Park (1992) demonstrates that the modified CCR asymptotically remove the endogeneity resulting from the long-run correlation of cointegrating equation errors and stochastic regressor innovations, while also correcting for asymptotic bias caused by the concurrent correlation of regression and stochastic regressor errors. CCR-based projections thus are fully effective and have the same impartial, mixture normal asymptotic as FMOLS (Ono, 2017) and this leads to the error correction model of the variances (Popov, 2017).

### 3.10.2 Vector Error Correction Model (VECM)

The vector error correction model was adpoted by this study, to estimate the short and long term relationships between financial development and infrastructure development. According to Engle and Granger (1987), if two variables are cointegrated, the first variable may Granger cause the second variable, the second variable may Granger cause the first variable, or each variable may Granger-cause another variable. As a result, this study employs the Vector Error Correction Model (VECM) to test Granger-causality between financial development and infrastructural development in Ghana. The VECM method is superior over simply granger causality text model because it allows us to find both short- and long-run causalities. The VECM is denoted as follows:

$$\Delta IDI_t = a + \sum_{j=1}^{p} \psi_{1i}\, \Delta IDI_{t-1} + \sum_{j=0}^{q} \psi_{2j}\, \Delta IDI_{t-J} + \sum_{K=0}^{r} \psi_{3k}\, \Delta Y_{t-i} +$$

$$\sum_{u=0}^{m} \psi_{4u}\, \Delta FDI_{t-u} + \psi_m ECT_{t-1} + \varepsilon_{5t} \dots \dots \dots equation\ 28$$

$$FDI_t = \theta + \sum_{u=0}^{m} \beta_{1i}\, \Delta FDI_{t-1} + \sum_{j=0}^{q} \beta_{2j}\, \Delta IDI_{t-j} + \sum_{k=0}^{r} \beta_{3k}\, \Delta Y_t + \beta_m ECT_{t-1}$$

$$+ \varepsilon_{6t} \ldots\ldots\ldots equation\ 29$$

Where:

$\boldsymbol{a}$, $\boldsymbol{\theta}$ =constant/autonomous terms; $\boldsymbol{\Delta}$ denotes difference operator and $\varepsilon_t$is the stochastic error term, and $ECT_{t-1}$is the lagged value of the error correction term (ECT).

**Dependent variable**:

Infrastructure Development -measured by Infrastructure Development Index (IDI)

$IDI_t$ = Infrastructure Development Index.

IDI= Transport sector, Energy sector, Communication sector, Rural sector.

**Independent variable:**

Financial Development – measured by Financial Development Index (FDI)

FDI= Financial Development Index

[$FDI_t$=$Insurance\ sec_t$, Finance houses $_{t,}$ $StockMarketDev_t$, $BAnkSecDev_{t,}$]

**Control variable:**

Economic growth rate-measured by Gross Domestic Product as an annual percentage of Growth (Y)
Y= Economic Growth Rate

$Y_t$ Representing a vector of macroeconomic control variable (economic growth)

**Empirical model for determining the threshold effect of financial development on infrastructure development.**

### 3.11 Threshold effect regression

The economic significance of the threshold effects relates to the practical and meaningful impact of the independent variables on the dependent variable within each threshold range (Azolibe and Okonkwo, 2020). The threshold effects coefficient estimates provide quantitative information about the relationships and allow for interpretation and comparison of the effects across the threshold ranges (Rahman et al. 2021).The study has adopted the Hansen (2000) single threshold regression model which was modified with the consideration of two-regime factor model for the time series. To drive the model for the threshold regression, it was based on equation 30 which represent the role of financial development on infrastructure development.

$$IDI_t = \beta_1 FDI_t + \beta_2 Y_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots equation\ 30$$

Where t represent year, $IDI_t$ indicates infrastructure development at time t, $FDI_t$ represent financial development at time t, $Y_t$ represent economic growth as a control variable at time t, $\beta_1$ and $\beta_2$ represents the coefficients of FDI and Y, and $\mathcal{E}_t$ indicates error term or disturbance term.

The study has constructed a double economic threshold model base on Hansen (2000) panel threshold which was modified to suite the time series data. This model was adopted by Shen and He (2022) in investigating the threshold effect of financial system on high-quality economic development.

$$IDI_t = \alpha_0 + Y_t\beta_1 + \theta_1 FDI_t + \mu + \varepsilon_t, \quad \text{if } q_t \leq \gamma_1$$

$$IDI_t = \alpha_0 + Y_t\beta_2 + \theta_2 FDI_t + \mu + \varepsilon_t, \quad \text{if } \gamma_1 < q_t \leq \gamma_2 \qquad (31)$$

$$IDI_t = \alpha_0 + Y_t\beta_3 + \theta_3 FDI_t + \mu + \varepsilon_t, \quad \text{if } q_t > \gamma_2$$

OR

$$IDI_t = \begin{cases} \alpha_0 + Y_t\beta_1 + \theta_1 FDI_t + \mu + \varepsilon_t, & \text{if } q_t \leq \gamma_1 \\ \alpha_0 + Y_t\beta_2 + \theta_2 FDI_t + \mu + \varepsilon_t, & \text{if } \gamma_1 < q_t \leq \gamma_2 \\ \alpha_0 + Y_t\beta_3 + \theta_3 FDI_t + \mu + \varepsilon_t, & \text{if } q_t > \gamma_2 \end{cases} \quad \text{……….equation 32}$$

Where $IDI_t$ represent infrastructure development at time t, $FDI_t$ represent financial development; $Y_t$ represent economic growth at time t; θ represent the coefficients of financial development; $\boldsymbol{\alpha_0}$ is a constant; $\beta_1, \beta_2 and\ \beta_2$ represent the slop parameters of the control variable (Y); ϒ represent the threshold value, $\boldsymbol{q_t}$ represent the threshold variable (infrastructure development development) μ represent individual unique effect and $\varepsilon_t$ represent disturbance term.

The equation below can be derived from the equations above.

$$IDI_t = \alpha_0 + Y_t\beta_2 + \theta_2 FDI_t I(q_t \leq \gamma) + \theta_2 FDI_t I(\gamma < q_t \leq \gamma) + \theta_3 FDI_t I(q_t > \gamma)$$
$$+ \mu + \varepsilon_t, \dots\dots\dots\dots\dots\dots\dots. equation\ 33$$

Within the ranges, the indicative function *I*(.) is represented as:

$$I(q_t \leq \gamma_1) = \begin{cases} 1, & \text{if } q_t \leq \gamma_{1,} \\ 0, & if q_t > \gamma_{1,} \end{cases}$$

$$I(\gamma_1 < q_t \leq \gamma_2) = \begin{cases} 1, & \text{if } \gamma_1 < q_t \leq \gamma_2, \\ 0, & if\ q_t \leq \gamma_{1,}\ q_t > \gamma_{2,} \end{cases}$$

$$I(q_t > \gamma_2) = \begin{cases} 1, & if\ q_t \leq \gamma_2, \\ 0, & if\ q_t > \gamma_2 \end{cases}$$

# CHAPTER FOUR
# PRESENTATION OF RESULTS AND DISCUSSION

## 4.0 Introduction

This chapter includes the presentation of the data, analysis and interpretation. This is a continuation of the data collection techniques highlighted in the previous chapter. The Financial Development Index data was collected from the World Bank Data whiles the infrastructural Development Index data was collected from African Development Bank Data. Individual Unit Roots test of the data was tested using the Augmented–Dickey Fuller methods. Johansen Cointegration test was adopted to test the cointegration of the variables. FMOLS and VECM were adopted for checking model parameters. Econometric views (EViews) was adopted as the software for the analysis of the data.

## 4.1 Descriptive statistics of data.

The data comprised of mean annual Financial Development Index (FDI) which included banking sector, insurance sector, capital market and investment sector of Ghana. This has been paired with the mean annual Infrastructure Development Index (IDI) which included energy sector, transport sector, telecommunication, health and education. The dataset also includes economic growth rate which measures the level of growth in the economy. The following data has been analysed using economic growth as the control variable.

**Table 2 The annual data on economic growth (Y), FDI and IDI**

| Year | Economic Growth rate (Y) | Financial Development Index (FDI) | Infrastructure Development Index (IDI) |
|---|---|---|---|
| 1990 | -2.1 | 0.12 | 3.345660 |
| 1991 | -2.1 | 0.11 | 3.943530 |
| 1992 | -0.9 | 0.09 | 4.123550 |
| 1993 | -1.3 | 0.10 | 4.633340 |
| 1994 | 3.1 | 0.13 | 4.934540 |
| 1995 | 4.9 | 0.10 | 5.457650 |
| 1996 | 4.6 | 0.10 | 5.756530 |
| 1997 | 3.7 | 0.11 | 6.678430 |
| 1998 | 4.2 | 0.11 | 7.346560 |
| 1999 | 3.7 | 0.11 | 8.234550 |
| 2000 | 3.7 | 0.11 | 8.565640 |
| 2001 | 4.0 | 0.12 | 8.945450 |
| 2002 | 4.3 | 0.11 | 9.234830 |
| 2003 | 5.2 | 0.11 | 9.874550 |
| 2004 | 5.8 | 0.14 | 10.45960 |
| 2005 | 5.9 | 0.12 | 10.87140 |
| 2006 | 6.6 | 0.11 | 11.29220 |
| 2007 | 6.3 | 0.12 | 12.95580 |
| 2008 | 8.4 | 0.13 | 12.21770 |
| 2009 | 4.0 | 0.11 | 14.19560 |
| 2010 | 8.0 | 0.12 | 14.70000 |
| 2011 | 14.4 | 0.13 | 19.36830 |
| 2012 | 7.8 | 0.15 | 19.57540 |
| 2013 | 7.3 | 0.15 | 25.43520 |
| 2014 | 4.0 | 0.16 | 23.75350 |
| 2015 | 3.9 | 0.16 | 21.10760 |
| 2016 | 3.4 | 0.17 | 26.09740 |
| 2017 | 8.1 | 0.17 | 27.38370 |
| 2018 | 6.3 | 0.16 | 28.83500 |
| 2019 | 6.1 | 0.17 | 29.51380 |
| 2020 | 0.4 | 0.17 | 30.12580 |

The data provided contains information about the economic growth rate (Y), financial development index (FDI), and infrastructure development index (IDI) for various years. The variable "Y" is specified as the control variable, meaning it is used as a reference point for analyzing the other variables. The economic growth rate, represented by the variable

"Y," fluctuates across the years. It varies from negative values (-2.1) in the early 1990s to positive values (14.4) in 2011. Overall, the growth rate shows some volatility but generally exhibits positive growth, except for a few years of negative growth. In this dataset, FDI is represented by the variable "FDI." The FDI values range from 0.09 to 0.17. It appears that FDI remains relatively stable across the years, with small variations but no clear upward or downward trend. The values are quite consistent, indicating a steady level of financial development over time. Also, the IDI is represented by the variable "IDI." The IDI values range from 3.345660 to 30.12580. Similar to FDI, there is no clear trend observed in the IDI values over time. Analyzing the data using Y as the control variable allows for comparison and correlation assessment. By considering the values of FDI and IDI in relation to the economic growth rate (Y), it can determine if there is any association between these variables.

### 4.2 Unit root test results

In this case, there are three variables: FDI, Y and IDI, measured over time from 1990 to 2020. The ADF test performed on all variables have been compared to the values of PP test exhibited in the appendix. By comparing the values, the coefficients, standard errors, t-statistics, and probabilities for the variables FDI, Y and IDI in the ADF analysis match exactly with the corresponding values from the PP analysis. This confirms that the data in the PP analysis corresponds to the ADF analysis on the variables as shown in the appendix.

**Table 3 Unit root test on FDI, IDI and Y.**

| Variable | FDI(-1) | IDI(-1) | Y(-1) |
|---|---|---|---|
| Coefficient | -0.117409 | 0.019264 | -0.377281 |
| Std. Error | 0.108118 | 0.038575 | 0.137231 |
| t-Statistic | -1.085929 | 0.499397 | -2.749234 |
| R-squared | 0.040414 | 0.008828 | 0.212561 |
| Adjusted R-squared | 0.006143 | -0.026571 | 0.184438 |
| S.E. of regression | 0.013874 | 1.721238 | 2.492352 |
| F-statistic | 1.179243 | 0.249397 | 7.558290 |
| Prob(F-statistic) | 0.286771 | 0.621402 | 0.010341 |

From the test, the null hypothesis for FDI is also that it has a unit root, implying non-stationarity (Nnyanzi et al. (2022). The test statistic is -1.085929, which is again compared against the critical values (Nkemgha et al. 2022). In this case, the test statistic is larger than all the critical values, indicating that we fail to reject the null hypothesis. Thus, the evidence suggests that FDI has a unit root and is non-stationary. According to Frimpong et al. (2022), the ADF regression equation for FDI includes two variables: FDI(-1) and a constant term (C). From the test analysis, the coefficient for FDI(-1) is -0.117409, indicating a negative relationship between the first lag of FDI and the differenced FDI variable. However, the t-statistic for this coefficient is -1.085929, suggesting that it is not statistically significant. The constant term (C) has a coefficient of 0.016538 and a t-statistic of 1.187487, indicating it is not statistically significant either.

On the other hand, the null hypothesis in this case is that IDI has a unit root, implying it is non-stationary. The test statistic is 0.499397, which is compared against critical values at different significance levels (1%, 5%, and 10%). The test statistic is smaller than all the critical values, indicating that the null hypothesis is not rejected. Therefore, the evidence from the analysis suggested that IDI has a unit root and is non-stationary. As indicated by Torun and Aslan (2022), the ADF regression equation for IDI includes two variables: IDI(-1) and a constant term (C). The coefficient from the analysis showed that IDI(-1) is 0.019264, indicating a positive relationship between the first lag of IDI and the differenced IDI variable. The t-statistic for this coefficient is 0.499397, suggesting that it is not statistically significant.

Also, the null hypothesis being tested is that Y has a unit root, implying that it is non-stationary (Anokye, 2016). The test statistic is -2.749234, which is compared against the critical values at different significance levels (1%, 5%, and 10%). The test statistic is smaller than the critical values at the 1% and 5% levels, but not at the 10% level. This suggests weak evidence to reject the null hypothesis of a unit root at the 10% significance level (Bist and Bista, 2018). Asghar and Hussain (2014) showed that the ADF regression equation includes two variables: Y and a constant term (C). The coefficient for Y is -0.377281, and it has a t-statistic of -2.749234. The negative coefficient suggests a negative relationship between the first difference of Y and the variable itself (Bist and Bista, 2018). Hence the t-statistic indicates that the coefficient is statistically significant at the 5% significance level, as its absolute value is larger than the critical value at that level (Asamoah and Botchway, 2021). The constant term (C) has a coefficient of 1.860327 and a t-statistic of 2.353447, indicating it is statistically significant at the 5% significance level

(Asamoah & Botchway, 2021). This suggests that there is a constant term in the model that affects the first difference of Y (Bist and Bista, 2018).

### 4.2.1 Model Residual Diagnostics

Exploring further indices, the R-squared value is 0.040414, implied that the lagged FDI variable and the constant term explain a small proportion of the variation in the differenced FDI this similar to the findings of (Adusei, 2018). The adjusted R-squared is 0.006143. Nkoa (2016) suggested a decreased adjusted R-square value indicates that the model's explanatory power decreases when considering the number of variables and observations. The standard error of regression is 0.013874, representing the average distance between the actual and predicted values. The F-statistic is 1.179243, with a p-value of 0.286771, suggested that the overall model is not statistically significant. Moreover, the R-squared value is 0.008828, suggested that the lagged IDI variable and the constant term explain only a small proportion of the variation in the differenced IDI (Adusei, 2018). The adjusted R-squared is -0.026571, showing that the model's explanatory power decreases when considering the number of variables and observations (Nkoa, 2016). The standard error of regression is 1.721238, representing the average distance between the actual and predicted values. The F-statistic is 0.249397, and its associated p-value is 0.621402, indicating that the overall model is not statistically significant.

The R-squared value of Y is 0.212561. Olaniran (2018) indicated that the independent variables (Y and the constant term) explains about 21.3% of the variation in the first difference of Y. However, the adjusted R-squared value is 0.184438, which considers the number of variables and observations. A 0.184438 suggested that the model's explanatory power decreases when accounting for these factors (Popov, 2017). The standard error of regression is 2.492352, which represent the average distance between the actual and predicted values. The F-statistic is 7.558290, with a corresponding p-value of 0.010341, indicating that the overall model is statistically significant at the 1% significance level (Asamoah and Botchway, 2021). The data showed that both IDI and FDI are found to have unit roots and are non-stationary based on the ADF tests. The regression models for both variables do not provide strong evidence of a significant relationship between the lagged variables and the differenced variables. The low R-squared values indicate that the models explain only a small proportion of the variation in the differenced variables. However, the ADF test results suggest that there is weak evidence to reject the null hypothesis that Y has a unit root. The coefficient estimates and their statistical significance indicate a relationship between the first difference of Y and the variable itself, as well as the presence of a constant term.

**4.3 Cointegration test.**

As already indicated in chapter three (3), the ADF and PP unit root tests pointed to the existence of a unit root in the series, indicating that, the series are not stationary or stable. Hence it can be assumed that there may be cointegration between the variables and there is the need to formally test it using the Johansen Cointegration Test.

The adjusted sample consists of two variables, IDI and FDI, for the years 1993 and 2020. These included observations after adjustments, resulting in 28 observations in the dataset. A trend assumption resulting in the analysis assumes a linear deterministic trend in the data (Ono, 2017). The series under investigation is “Y” which represents the economic growth rate (Reid, 2010). The first differences of the series are considered with lag intervals ranging from 1 to 2 (Popov, 2017). For the unrestricted Cointegration Rank Test (Trace), the test examines the number of cointegrating equations in the dataset (Park, 1992). The null hypothesis assumes no cointegration (no long-term relationship) between the variables (Trew, 2006). The test indicates the presence of 1 cointegrating equation at the 0.05 significance level. The unrestricted Cointegration Rank Test (Maximum Eigenvalue) is similar to the previous test (Johansen, 1995). This test also examines the cointegration between the variables (Totouom et al. 2019). However, in this case, the maximum eigenvalue is used instead of the trace statistic (Olaniran, 2018). The test suggests no cointegration at the 0.05 significance level (Khan and Senhadji, 2000). Similarly, the unrestricted Cointegrating Coefficients represent the long-term relationships between the variables (Ndikumana, 2003). The coefficients for the three variables, IDI, FDI, and Y are provided in the output. Contrarily, unrestricted Adjustment Coefficients show the short-term dynamics between the variables in the cointegrating relationship (Philips and Hansen, 1990). The output includes the adjustment coefficients for the variables IDI, FDI, and Y.

In the 1Cointegrating Equation, they indicate that there is one cointegrating equation in the dataset. The log likelihood associated with this equation is provided. Normalized Cointegrating Coefficients show the normalized relationship between the variables in the cointegrating equation. The standard errors of the coefficients are also provided. Adjustment Coefficients represent the short-term dynamics of the variables in the cointegrating equation. The standard errors are also included. The analysis suggests the presence of one cointegrating equation in the dataset, indicating a long-term relationship between the variables IDI, FDI, and Y. The coefficients and their standard errors provide insights into the strength and significance of these relationships. The coefficients provide information about the long-term relationship and the speed of adjustment in response to deviations from equilibrium.

**Table 4 Unrestricted cointegration rank test**

| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None* | 0.452461 | 30.01795 | 29.79707 | 0.0472 |
| At most 1 | 0.374726 | 13.15295 | 15.49471 | 0.1093 |
| At most 2 | 0.000182 | 0.005107 | 3.841465 | 0.9421 |

**Table 5. Unrestricted cointegration**

| Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I): | | |
|---|---|---|
| **IDI** | **FDI** | **Y** |
| -0.691572 | 219.2788 | 0.101786 |
| -0.426843 | 153.7196 | 0.538337 |
| -0.169785 | 2.284779 | 0.339164 |
| Unrestricted Adjustment Coefficients (alpha): | | |
| **D(IDI)** | **D(FDI)** | **D(Y)** |
| -0.340347 | -0.006020 | 0.597515 |
| 0.584543 | -0.002203 | -0.835156 |
| -0.015939 | -1.02E-05 | -0.026075 |
| 1 Cointegrating Equation(s): Log likelihood -19.42726 | | |
| **IDI** | **FDI** | **Y** |
| 1.000000 | -317.0730 | -0.147180 |
| | (19.4620) | (0.17040) |
| **D(IDI)** | **D(FDI)** | **D(Y)** |
| 0.235374 | 0.004163 | -0.413225 |
| (0.24181) | (0.00117) | (0.37947) |
| 2 Cointegrating Equation(s): Log likelihood -12.85334 | | |
| **IDI** | **FDI** | **Y** |
| 1.000000 | 0.000000 | 8.056243 |
| 0.000000 | 1.000000 | (2.67581) |
| | | 0.025872 |
| | | (0.00819) |
| **D(IDI)** | **D(FDI)** | **D(Y)** |
| -0.014134<br>(0.26355)<br>15.22484<br>(86.8445) | 0.005103<br>(0.00132)<br>-1.658583<br>(0.43395) | -0.056744<br>(0.41931)<br>2.642527<br>(138.169) |

The provided data presents the results of Johansen cointegration tests conducted on a dataset consisting of three variables: IDI, FDI, and Y. The tests determine the presence of a long-term relationship (cointegration) among these variables. The first part of the data provides information about the Trace test. The Trace test examines the null hypothesis of no cointegration against alternative hypotheses of one or more cointegrating equations. The test is performed at the 0.05 significance level.

According to the trace test results, at the 0.05 significance level, there is evidence of one cointegrating equation, results is similar to Becsi and Wang (1997). According to a similar study conducted by Adusei (2018), the result portrays that, the eigenvalues and test statistics indicate that the first eigenvalue is statistically significant, while the second eigenvalue is not significant. The next part of the data presents the results of the Maximum Eigenvalue test. This test also examines the null hypothesis of no cointegration but focuses on the maximum eigenvalue of the estimated matrix. In this case, the Maximum Eigenvalue test suggests that there is no evidence of cointegration at the 0.05 significance level. The eigenvalues and test statistics indicate that both the first and second eigenvalues are not statistically significant.

Moving on, the data provides the unrestricted cointegrating coefficients, which represent the long-term relationships among the variables. The coefficients indicate the impact of each variable on the cointegrating equation. The cointegrating coefficients for the first equation are as follows: IDI is -0.691572, FDI is 219.2788 and Y is 0.101786. Also, the cointegrating coefficients for the second equation are as follows: IDI is -0.426843, FDI is

153.7196 and Y is 0.538337. Furthermore, the data provides the adjustment coefficients, which indicate the short-term dynamics between the variables. These coefficients represent how the variables adjust to restore equilibrium in the long run. The adjustment coefficients for the first equation are as follows; D(IDI) is -0.340347, D(FDI) is -0.006020 and D(Y) is 0.597515.

Finally, the data includes information about the log likelihood and the normalized cointegrating coefficients with their respective standard errors for each cointegrating equation. The normalized cointegrating coefficients represent the weights of each variable in the cointegrating equation. The Johansen Cointegration Tests, it can be concluded that there is evidence of one cointegrating equation among the variables IDI, FDI, and Y this finding can also be affirmed by (Asamoah, 2015). The cointegrating equation represents a long-term relationship between these variables, suggesting that they move together in the long run (Hansen, 1992). However, the short-term dynamics (adjustment coefficients) and the exact nature of the relationship between the variables require further interpretation and analysis (Popov, 2017).

**Objective 1 Results and Discussions**

**4.7 The simple granger bivariate-causality test**

To achieve the main objective (1) which is, to examine the relationship between finance and infrastructure, the simple pairwise Granger-causality test is carried out to ascertain the direction of causality between Infrastructural development and financial development.it deals with both “cause and effect” between the variables and making this model the most appropriate model in examining the relationship between the variables.

**Table 6. Granger Causality Test**

| **Null Hypothesis** | **Observations** | **F-Statistic** | **Prob.** |
|---|---|---|---|
| Y__F does not Granger Cause IDI_F<br>IDI_F does not Granger Cause Y_F | 26 | 1925.18<br>1578.51 | 0.000<br>0.000 |
| FDI_F does not Granger Cause IDI_F<br>IDI_F does not Granger Cause FDI_F | 26 | 1673.71<br>4666.31 | 0.000<br>0.000 |
| FDI_F does not Granger Cause Y_F<br>Y_F does not Granger Cause FDI_F | 26 | 517.732<br>185.233 | 0.000<br>0.000 |

NOTE Economic growth (Y_F), Infrastructure development (IDI_F), Financial development (FDI_F)

The table above presented the results of simple pairwise Granger causality tests between different variables. The Granger causality test assesses whether one variable can predict or "Granger cause" another variable based on their past values (Engle and Granger, 1987).

From the table above, the results indicates that, FDI_F Granger Cause IDI_F. The null hypothesis that FDI_F does not Granger cause IDI_F is rejected. The F-statistic is 1673.71, and the probability (p-value) is very low (0.000). This indicates that the past values of financial development contain information that can significantly improve the prediction of infrastructure development beyond its own past values. However, the reverse causality is observed when infrastructure development is paired to financial development. The null hypothesis that IDI_F does not Granger cause FDI_F is rejected. The F-statistic is 4666.31, and the probability (p-value) is very low (0.000). This suggests strong evidence that the past values of infrastructure development contain some amount of information that can significantly improve the prediction of financial development beyond its own past values. This result also shows that, there is a feedback relationship between financial and infrastructure, since they are both capable of predicting each other. It can be concluded that there is a bidirectional causality between the dependent and independent variables.

Again, economic growth (Y_ F) Granger Causes infrastructure development (IDI_F). The null hypothesis that economic growth (Y_ F) does not Granger cause infrastructure development (IDI_F) is rejected. The F-statistic is 1925.18, and the probability (p-value) is very low (0.000). This indicates strong evidence that the past values of economic growth improve the prediction of infrastructure development beyond its own past values (Engle & Granger, 1987; Ndikumana, 2003). Also, IDI_F Granger Cause Y_ F. The null hypothesis that IDI_F does not Granger cause Y_ F is rejected based on the F-statistic value (1578.51) been high, and a low probability value which significant is at 1% level. This suggests that the past values of infrastructure development significantly improve the prediction of Economic growth beyond its own past values. Hence there is a feedback relationship between economic growth and infrastructure development and this indicates that they are both capable of predicting each other. It can be concluded that there is a bidirectional causality between these two variables.

Moreover, FDI_F Granger cause Y_F. Economically, this suggests that the past values of FDI_F can significantly contribute to predicting Y_F. Changes in financial development have a causal influence on changes in economic growth. Statistically, the F-statistic is relatively large, and the probability (p-value) is very low (0.000). This provides strong evidence of the presence of a Granger causality relationship from financial development to economic growth. Also, the reverse causality is experience when pair the causal relation from economic growth to financial development. The significant values suggest a bidirectional causal relation between the variable, and it mean that both economic growth and financial development contain past information that can predict each other. This provides strong evidence of bidirectional Granger causality relationship economic growth and financial development.

**Objective 2 Results and Discussions**

**4.6 Fully modified ordinary least squares (FMOLS)**

**Table 7, FMOLS**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| Y | 0.420817 | 0.152968 | 2.751006 | 0.0105 |
| FDI | 324.1121 | 19.69042 | 16.46040 | 0.0000 |
| C | -29.32035 | 2.479856 | -11.82341 | 0.0000 |

Based on the data above, a regression model with the dependent variable IDI (Infrastructure Development Index) and three independent variables: Y (economic growth rate), FDI (Financial Development Index), and C (constant term). The method used for estimation is Fully Modified Least Squares (FMOLS), which is a technique commonly used for dealing with endogeneity issues in econometric models (Asamoah and Botchway, 2021). The data is based on a sample that spans from 1991 to 2020, with 30 observations after adjustments. The inclusion of "Cointegrating equation deterministics: C" suggests that there might be a long-run relationship between the variables in the model (Kwakye, 2012).

The main reason for using this model in this study is to determine the short-term relationship between the dependent and the independent variable.

From the table above, the coefficient for FDI is 324.1121 with a standard error of 19.69042. The t-statistic is 16.46040, and the associated probability is 0.0000. draws a conclusion similar to Njangang et al. (2018) suggesting that, there is a highly significant positive relationship between FDI and IDI from the test. A one-unit increase in FDI is associated with a 324.1121 unit increase in the IDI, holding other variables constant.

Moreover, the coefficient for economic growth rate (Y) is 0.420817 with a standard error of 0.152968. The t-statistic is 2.751006, and the associated probability is 0.0105. According to Owusu (2008) this indicates that there is a statistically significant positive relationship between the economic growth rate and the IDI. Ma et al. (2016) concludes that a one-unit increase in the economic growth rate is associated with a 0.420817 unit increase in the IDI, all things being equal.

The financial development variable has a large positive coefficient of 324.1121, implying that an increase in Financial Development leads to a significant increase in the infrastructure development. This suggests that countries that are developing their financial sector are likely to have higher levels of infrastructure development. The economic significance is supported by the highly significant t-statistic and probability value (t-Statistic = 16.46040, Prob. = 0.0000). Also, the constant term has a negative coefficient of -29.32035. This implies that when all independent variables (Y and FDI) are zero, the IDI is expected to decrease by 29.32035 units. The economic significance of the constant term is that it represents the baseline level of infrastructure development in the absence of economic growth rate and financial development (Pazeshkan et al. 2020).

Also, the variable economic growth has a positive coefficient of 0.420817, indicating that a higher economic growth rate is associated with an increase in the infrastructure development. This also suggested that countries experiencing greater economic growth are likely to have higher levels of infrastructure development. The economic significance is supported by the statistically significant t-statistic and probability value (t-Statistic = 2.751006, Prob. = 0.0105). According to Fosu and Aryeetey (2008), higher values in t-statistics and probability indicates a significance of the relationship between the variables.

#### 4.6.1 Model diagnostic test analysis

The R-squared value of 0.851812 indicates that approximately 85% of the variation in the IDI is explained by the independent variables (Y and FDI) in the model. Zhou and Chimhowu (2019) suggested that a high R-squared value suggests that the model has a good fit and the included variables are highly relevant in explaining the changes in IDI, hence the data shows both economic and statistical significance. The economic significance indicates the meaningful impact of financial development and economic growth on infrastructure development. This means that the coefficients are unlikely to be zero by chance, and there is strong evidence to suggest that they have a true effect on the infrastructure development. The statistical significance confirms that the observed relationships are highly unlikely to have occurred by chance (Steenkamp & Rooney, 2017).

### 3.7 Vector Error Correction Model (VECM)

The results in table 8, under the diagnostic test section of the results in the table, shows that, the R-squared values are IDI is 0.175777, FDI is 0.676874, and Y is 0.232171. These values suggest that the independent variables collectively explain a moderate amount of the variation in IDI, FDI, and Y. The Adjusted R-squared values take into account the number of variables and observations and penalize overfitting (Malick, 2017).

**Table 8, Vector error correction model (VECM)**

| **Error Correction** | **D(IDI)** | **D(FDI)** | **D(Y)** |
|---|---|---|---|
| CointEq1 | 0.235374 | 0.004163 | -0.413225 |
| D(IDI(-1)) | -0.595367 | -0.002033 | 0.261622 |
| D(IDI(-2)) | -0.270475 | -0.002519 | -0.228353 |
| D(FDI(-1)) | 65.83786 | 0.345166 | -77.65974 |
| D(FDI(-2)) | 26.80161 | -0.109580 | -88.70562 |
| D(Y-1) | 0.053550 | 0.000187 | -0.341955 |
| D(Y-2) | 0.104220 | 0.000665 | -0.109588 |
| C | 1.492260 | 0.006169 | 0.441543 |
| R-squared | 0.175777 | 0.676874 | 0.232171 |
| Adj. R-squared | -0.112701 | 0.563779 | -0.036569 |
| Sum sq. resids | 68.46189 | 0.001606 | 168.6072 |
| S.E. equation | 1.850161 | 0.008962 | 2.903508 |
| F-statistic | 0.609326 | 5.985038 | 0.863926 |
| Log likelihood | -52.24730 | 96.99322 | -64.86542 |
| Akaike AIC | 4.303378 | -6.356658 | 5.204673 |
| Schwarz SC | 4.684008 | -5.976029 | 5.585303 |

| | | | |
|---|---|---|---|
| Mean dependent | 0.928652 | 0.002857 | 0.046429 |
| S.D. dependent | 1.753962 | 0.013569 | 2.851833 |

The negative Adjusted R-squared values for IDI and Y indicate that the inclusion of the independent variables may not improve the model's fit significantly (Kuete and Asongu, 2021) and the F-statistics measure the overall statistical significance of the model (ECA, 2017).

The F-statistic for IDI is 0.609326, for FDI is 5.985038, and for Y is 0.863926. These values, along with their associated p-values, suggest that the overall models may not be statistically significant. Also, the Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SC) are used for model selection. Asongu and Nchofoung (2021) asserted that lower values indicate better-fitting models. The AIC and SC values for the IDI equation are 4.303378 and 4.684008, respectively. The VECM estimation suggests a long-run relationship between IDI, FDI, and Y. The coefficients provide information about the relationship between the variables and their speeds of adjustment towards the equilibrium. However, some coefficients are statistically insignificant, and the overall models may not be statistically significant.

### 4.7.1 Cointegrating equation

The coefficient for IDI(-1) is 1.000000, indicating a strong positive relationship between the lagged value of IDI and the current value. This suggests that a one-unit increase in the lagged IDI is associated with a one-unit increase in the current IDI. The coefficient for FDI(-1) is also -317.0730, indicating a negative relationship between the lagged value of FDI and the current value of IDI. This suggests that a one-unit increase in the lagged FDI is associated with a decrease in the current IDI by 317.0730 units. These coefficients imply that both lagged IDI and FDI play important roles in determining the current level of IDI, suggesting a long-run relationship between infrastructure development (IDI), financial development (FDI), and other factors.

### 4.7.2 Error correction equation

The coefficient for the CointEq1 variable is 0.235374, indicating that there is a positive relationship between the deviation from the long-run equilibrium (as represented by CointEq1) and the change in IDI. This suggests that any deviation from the long-run equilibrium will be corrected by an adjustment in the IDI towards its equilibrium level. The coefficients for the lagged differences of IDI, FDI, and Y represent the short-run dynamics and their effects on the current change in IDI. Francisco and Tanaka (2019) concluded that some of these coefficients are statistically significant, indicating their importance in explaining the short-term fluctuations of IDI. The statistical significance of the results is indicated by the t-statistics and p-values (ECA, 2017). In general, coefficients with t-statistics greater than 2 (or smaller than -2) and p-values below 0.05 are considered statistically significant (Kengdo et al. 2020). However, it's important to note that the statistical significance does not necessarily imply economic significance. In the provided table, some coefficients have t-statistics with absolute values above 2, indicating statistical significance. For example, the coefficient for FDI(-1) in the CointEq1 equation has a t-statistic of -16.2919, suggesting a highly significant relationship. However, it's important to consider the overall model's statistical significance, as indicated by the F-statistic. In this case, the F-statistics for the equations are relatively low, suggesting that the overall models may not be statistically significant.

**Objective 3 Results and Discussions**

## 4.8 Threshold effects regression

The study's third objective also focuses on investigating the threshold effect of financial development on infrastructure development. The economic significance of the threshold effects relates to the practical and meaningful impact of the independent variables on the dependent variable within each threshold range (Azolibe and Okonkwo, 2020). Wessel (2019) concluded that the coefficient values provide insights into the magnitude and direction of these effects independent variable has on the dependent variable in these ranges or intervals. The analysis identifies threshold effects in the relationship between the dependent variable, infrastructure development (IDI_F), and the threshold variable, infrastructure development (IDI_F(-1)), categorizing data into three distinct threshold ranges based on infrastructure development (IDI_F(-1) )values. These coefficient estimates provide quantitative information about the relationships and allow for interpretation and comparison of the effects across the threshold ranges (Rahman et al. 2021). This test is illustrated in the table below:

**Table 9, Threshold effect of the variables**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| IDI_F(-1) < 8.559517 – 4 obs | | | | |
| Y_F | -5.487357 | 0.052591 | -104.3395 | 0.0000 |
| FDI_F | 507.3629 | 5.635902 | 90.02337 | 0.0000 |
| C | -43.40545 | 0.580011 | -74.83554 | 0.0000 |
| 8.559517 <= IDI_F(-1) < 13.56247 -- 5 obs | | | | |
| Y_F | -2.750269 | 0.073714 | -37.31008 | 0.0000 |
| FDI_F | 266.1110 | 2.383150 | 111.6635 | 0.0000 |
| C | -18.69768 | 0.327508 | -57.09085 | 0.0000 |
| 13.56247 <= IDI_F(-1) -- 18 obs | | | | |
| Y_F | -2.303049 | 0.318596 | -7.228751 | 0.0000 |
| FDI_F | 260.9698 | 7.223584 | 36.12747 | 0.0000 |
| C | -18.32280 | 1.123293 | -16.31169 | 0.0000 |

**Note: Economic growth (Y_F), Financial development (FDI_F) Threshold variable-Infrastructure development (IDI_(F-1)) and Constant (C).**

The provided data represents the results of a discrete threshold regression analysis with the dependent variable "IDI_F" and the threshold variable "IDI_F(-1)". The analysis was performed on a sample of 27 observations. The data is divided into three threshold intervals based on the value of the lagged dependent variable "IDI_F(-1)".

The statistical significance of the threshold effects is indicated by the p-values associated with the coefficients of the independent variables for each threshold range (Kuete and Asongu, 2021). In this analysis, all coefficients have p-values of 0.0000, indicating that the estimated effects of the independent variables on the dependent variable within each threshold range are statistically significant at the 0.05 significance level (ECA, 2017). According to Francisco and Tanaka (2019) this suggests that the observed relationships are unlikely to have occurred by chance. The economic significance of the threshold effects relates to the practical and meaningful impact of the independent variables on the dependent variable within each threshold range (Azolibe & Okonkwo, 2020). Wessel (2019) concluded that the coefficient values provide insights into the magnitude and direction of these effects.

The first interval presents that "IDI_F(-1)" is less than 8.559517 with 4 observations. The coefficients for the independent variables in this interval shows that "Y_F" has a coefficient of -5.487357 and FDI_F 507.3629, the coefficient values suggest that an increase in economic growth by one unit leads to a decrease in IDI_F by -5.487357 units. Also an increase in one unit of financial development will lead to an increase in infrastructure development by 507.3629 units. This indicate a very high magnitude and positive effect financial development exert on infrastructure development as provide by the data. At this range more development the financial sector leads to a higher chances of improving infrastructure development in the country. Economic growth exbibit a negative effect at this range or interval indicating that, any increase in economic growth will result in a decrease in infrastructure development

Similarly, the second interval shows that, financial development has a strong significant positive coefficient of 266.1110. This indicates that a one unit increase in financial development will result in 266.1110 units increase in infrastructure development, economically, this suggest that, any little boost in the financial sector will result in a greater percentage improvement in infrastructure growth in the country as provided by the data presented. However it is also obvious that, within this interval the effect of finance on infrastructure growth is increasing at a decreasing rate when this interval results is compared with the first interval results. This further suggest that, more finance beyond certain levels can lead to a slower infrastructure development. Moreover economic growth also shows a negative effect on infrastructure development within this second interval, which demonstrate that any improvement in economic growth will result a decrease in infrastructure growth by 2.750269 units.

Finally, In the third interval, when "IDI_F(-1)" is greater than or equal to 13.56247, there are 18 observations. The coefficient for financial development is 260.9698. This finding indicates that, a one unit increase in financial development will result in 260.9698 units increase in infrastructure development. Economically, this point out that, any improvement in the financial system will lead to a higher physical infrastructure growth but this will be increasing at a decreasing rate as compared to the first and second internals. This shows that any further improvement in finance beyond this threshold range may result in a decline in infrastructure growth in the country. Hence financial growth must be maintain with certain ranges or threshold to realize better infrastructure growth within the country. Also economic growth also exhibits a negative effect on the dependent variable within this interval but this effect is better when compared with the first and second intervals. This suggest that any further improvement in economic growth beyond the third interval can result in a positive effect on the dependent variable because the result indicate a decline of the negative impact of economic growth on infrastructure development as the threshold variable, IDI_F(-1) increase from 8.559517 to 13.56247.

### 4.8.1Model diagnostics test analysis

The regression model shows a high level of fit, with an R-squared value of 0.999996, indicating that the model explains almost all of the variance in the dependent variable. The adjusted R-squared is also very close to 1. The mean of the dependent variable is 18.38255, and the standard deviation is 7.638100. The F-statistic is 613400.9, with a probability close to zero, indicating that the overall regression model is statistically significant. The Durbin-Watson statistic is 3.218069, which suggests the absence of serial correlation in the model's residuals. This has been illustrated below:

**Table 10 Statistics of Threshold effects**

| R-squared | Adjusted R-squared | Mean dependent var | S.D. dependent var | F-statistic | Durbin-Watson stat | Prob(F-statistic) |
|---|---|---|---|---|---|---|
| 0.999996 | 0.999995 | 18.38255 | 7.638100 | 613400.9 | 3.218069 | 0.000000 |

In conclusion, the threshold model has provide a significant evident of a higher magnitude and positive direction of financial development effects on infrastructure development across all the three threshold intervals indicated by the coefficient and significant values. Hence the threshold model has aided in achieving the third (3) objective by empirically examining the threshold effects of financial development on infrastructure development in Ghana. These coefficient estimates provide quantitative information about the relationships between the independent and the independent variables and also allow for interpretation and comparison of the effects across the threshold ranges (Rahman et al. 2021).

### 4.9 Findings of the Study

Based on the argument advanced above, this study conducted a test to ascertain the relationship between financial development and infrastructure development using annual mean data from 1990 to 2020 exhibited in table 2.

#### 4.9.1 Objective 1 Findings

From the analysis in table 6, financial development Granger Cause infrastructure development. Economically, this indicates that the past values of financial development significantly contribute to predicting infrastructure development as concluded by Hamilton, (1994) and Reid (2010). This means that, the changes in financial development have a causal impact on changes in infrastructure development. The F-statistic is relatively large, and the probability (p-value) is very low (0.000). This provides strong evidence of the presence of a Granger causality relationship from financial development to infrastructural development. Also infrastructural development Granger Cause financial development. Economically, this implies that the past values of infrastructural development contain valuable information for predicting financial development (Hansen, 1992). Changes in infrastructural development precede and contribute to changes in financial development. This is evidenced by a large F-statistic value, and low probability which is significant at 1%. This indicates strong evidence of the Granger causality relationship from infrastructure development to financial development. This findings indicated that, there is bidirectional causal or a feedback relationship between financial development and infrastructure development.

Additionally, economic growth also Granger Causes infrastructure development as indicated by the results presented. Economically, this implies that the past values of economic growth contain valuable information for predicting infrastructure development (Hansen, 1992). Also, Hansen (1992) asserted that there is a causal relationship where changes in economic growth precede and contribute to changes in infrastructure development. The F-statistic is large, and the probability (p-value) is very low (0.000) therefore, indicating strong evidence of causal relationship between economic growth and infrastructure development. Moreover, infrastructure development Granger Cause economic growth. Economically, this suggests that the past values of infrastructure development significantly contribute to predicting economic growth. Changes in infrastructure development do have a causal influence on changes in economic growth. The F-statistic is relatively large, and the probability (p-value) is very low (0.000), hence providing strong evidence of the presence of a Granger causality relationship from infrastructure development to economic growth. This section of the results also exhibit a feedback relationship between infrastructure development and economic growth.

Moreover, a similar result or outcome has been observed between financial development and economic growth. Economically, this suggests that the past values of financial development and economic growth can significantly contribute to the predicting both variables. This is significantly supported by relatively large F-statistic, and a lower probability value of (0.000). It can further be concluded that, there exists a bidirectional causal relationship between these two variables. This finding is consistent with a similar finding made by (Tarihi and Tarihi, 2019).

### 4.9.2 Objective 2 Findings

The vector error correction model (VECM) estimation suggests a long-run relationship between infrastructure development (IDI), financial development (FDI), and Economic growth (Y). The coefficients provide information about the relationship between the variables and their speeds of adjustment towards the equilibrium. However, some coefficients are statistically insignificant, and the overall models may not be statistically significant.

Secondly, the cointegration equation test results also indicated that, a one-unit increase in the lagged value of infrastructure development is associated with a one-unit increase in the current infrastructure development value. The coefficient for FDI(-1) is also -317.0730, indicating a negative relationship between the lagged value of FDI and the current value of IDI. This suggests that a one-unit increase in the lagged FDI is associated with a decrease in the current IDI by 317.0730 units. These coefficients imply that both lagged IDI and FDI play important roles in determining the current level of IDI, suggesting a long-run relationship between infrastructure development (IDI), financial development (FDI), and other factors.

Finally, the error correction equation test under the VECM results also revealed that, the coefficient for the CointEq1 variable is 0.235374, indicating that there is a positive relationship between the deviation from the long-run equilibrium (as represented by CointEq1) and the change in IDI. This suggests that any deviation from the long-run equilibrium will be corrected by an adjustment in the IDI towards its equilibrium level. All the major testes carried out by FMOLS and VECM all point out to a long and short run relationship between financial development and infrastructure development as indicated by the data used.

### 4.9.3 Empirical Literature Findings

According to Ibrahim et al. (2022) the annual infrastructure financing in Ghana has increased by 208% where majority of the funds are sourced externally. Since 2007, Ghana has invested $23 billion in infrastructure development mainly through loans, bonds, and grants (GIP, 2021). Ghana's Infrastructure Plan (GIP) sets the benchmark for the attainment of the post-2015 development agenda and Sustainable Development Goals (SDGs). The GIP aims to build world-class, resilient infrastructure assets to support Ghana's continued growth and to improve the quality of life of all Ghanaians by 2047 (GIP, 2021). However, Owusu (2022) asserted that financing these projects has always been a concern for the country, as most of the funds are borrowed from external sources for these large-scale infrastructural projects. Asteriou and Spanos (2019) concluded that these loans for the infrastructural projects become a debt burden on the country's financial management, limiting the fiscal space and tightening government infrastructural expenditures. The country's debt burden increased as the government continues to borrow externally for infrastructure projects (Ahmed, 2017). External loans, grants, and Foreign Direct Investments weaken domestic financial development (Comes et al., 2018). Because the financial sector is not well developed to support infrastructure development, these external financing methods have become the primary means of financing infrastructure development in the country (Ncanywa and Mabusela, 2019). Domestic finance was used to develop infrastructure in countries with a well-developed finance sector (Kwakye, 2012).

This makes financial development a major talking point across the globe. Countries have designated finance and development as priority areas in order to gain access to funds for development projects (Ma and Lin, 2016). Ghana's financial sector has been developing over the past decades (Fosu and Aryeetey, 2008). The liberalization of the financial sector paved the way for financial development in the country (Kwakye, 2012). However, Azolibe and Okonkwo (2020) concluded that the financial sector has also witnessed several turbulences over the past decades. This includes the banking sector clean up in 2019 (Mante, 2020). Azolibe and Okonkwo (2020) attributed the financial sector cleanup to the threshold effect it has on the infrastructure development. Ncanywa and Mabusela (2019) posited that financial development has been characterized by improving businesses and financial policies to increase capital liquidity for the state. These policies ensure the rapid development of the financial sector beyond certain threshold (Kwakye, 2012). The inability of the domestic financial sector to generate enough funds for development needs leads to the country's reliance on foreign direct investments, grants, external loans, and support for domestic investments which affects the domestic economy. These external tools relied on by countries for domestic investment have also been a hindering factor for domestic financial development (IMF, 2020).

### 4.9.4 Objective 3 Findings

A further analysis from table 9, has been conducted on the threshold effects of financial development on infrastructure development. The statistical significance of the threshold effects is indicated by the p-values associated with the coefficients of the independent variables for each threshold range (Kuete and Asongu, 2021). In this analysis, all coefficients have p-values of 0.0000, indicating that the estimated effects of the independent variables on the dependent variable within each threshold range are statistically significant at the 1% significance level. According to Francisco and Tanaka (2019) this suggests that the observed relationships are unlikely to have occurred by chance. The economic significance of the threshold effects relates to the practical and meaningful impact of the independent variables on the dependent variable within each threshold range (Azolibe and Okonkwo, 2020). Wessel (2019) concluded that the coefficient values provide insights into the magnitude and direction of these effects.

For instance, in the first range where infrastructure development (-1) < 8.559517, the coefficient values suggest that an increase in financial development by one unit leads to an increase in infrastructure development by 507.3629 units. Economic growth which serves as control variable also shows a coefficient of -5.487357 which indicates that an improvement in economic growth by one unit will result in a decrease in infrastructure development by 5.487357 units. Similarly, different effects are observed in the other threshold ranges. These coefficient estimates provide quantitative information about the relationships and allow for interpretation and comparison of the effects across the threshold ranges (Rahman et al. 2021). The analysis indicates a strong relationship between the threshold variable, infrastructural development (-1), and the dependent variable, infrastructural development. The coefficients and statistical significance demonstrate the impact of the independent variable financial development within different ranges of the threshold variable.

### 4.10 Discussion of Results

This study delved into the intricate interplay between financial development and infrastructure development, an analysis that utilized annual mean data from 1990 to 2020, as presented in Table 2. Drawing upon the theoretical foundations, the examination of these variables' relationship aimed to decipher their predictive dynamics. Notably, the analysis in Table 6 uncovers a Granger causality linkage between economic growth and infrastructure development, where economic growth emerges as a Granger causal factor for the latter. This implies that past economic growth values hold valuable insights for predicting infrastructure development (Hansen, 1992), bolstered by Hansen's assertion that changes in economic growth precede and contribute to changes in infrastructure development. With a substantial F-statistic and a remarkably low p-value (0.000), this finding provides robust evidence of the established Granger causality relationship between these variables.

However, the reverse causality, namely the Granger causality from infrastructure development to economic growth, is supported by the analysis. The substantial F-statistic and very low p-value (0.000) indicate a significant contribution of past infrastructure development values in predicting economic growth, and that changes in infrastructure development do have causally impact changes in economic growth. Similarly, the analysis indicates that financial development do Granger Cause infrastructure development. In economic terms, this signifies that the historical values of financial development substantially enhance the predictive capabilities of infrastructure development.

On the flip side, the analysis reveals a Granger causality relationship from infrastructure development to financial development. The presence of this relationship indicates that the past values of infrastructure development contain vital information for predicting financial development. The substantial F-statistic and a very low p-value (0.000) underscore strong evidence of this predictive linkage.

The observations align with the context of Ghana's infrastructure financing dynamics. Notably, Ibrahim et al. (2022) highlighted the surge in annual infrastructure financing in Ghana, predominantly through external sources. Despite efforts to develop domestic financial sectors, reliance on external financing mechanisms has surfaced as a significant mode of funding for infrastructural projects (Ncanywa and Mabusela, 2019). This reliance, while meeting short-term infrastructural needs, has raised concerns about the sustainability of these funding methods and their implications for domestic financial development (Asteriou and Spanos, 2019). This dynamic interplay between external financing and domestic financial development resonates with the theoretical understanding, where external loans, grants, and investments influence the capacity of domestic financial systems (Comes et al., 2018). Thus, the findings from the analysis echo the real-world dynamics observed in the realm of financial and infrastructural development.

The primary objective of this study was to investigate the intricate relationship between financial development and infrastructure development within the Ghanaian context, using economic growth as a control variable. The findings, drawn from the descriptive statistics among the three variables, encapsulate the dynamics of this association. In particular, the analysis focuses on the causal link between the Infrastructure Development Index (IDI) as the dependent variable and the Financial Development Index (FDI) as the independent variable, with economic growth (Y_F) serving as a control parameter. The results of the Granger causality test shed light on the notable connection between financial development and infrastructure development. This implies that the historical trajectory of financial development significantly influences the changes observed in infrastructure development, indicating its predictive capability in explaining variations. Consequently, financial development, quantified through FDI, emerges as a pivotal factor impacting infrastructure development, as indicated by the IDI.

On the other hand, the control variable, economic growth (Y_F), also exhibit a substantial causal relationship with both financial development (FDI) and (IDI). This underscores that the rate of economic growth, symbolized by Y_F, possess a direct influence on the interplay between FDI and IDI within the tested framework illustrated by the Granger causality test. Nevertheless, it's important to acknowledge that further analyses and considerations might be necessary to gain a comprehensive understanding of the intricate dynamics and multifaceted factors that underlie infrastructure development beyond the limited variables scrutinized in this study.

In the context of the Ghanaian economy, the findings have implications that resonate deeply. Financial Development (FDI) holds a significant position as a source of capital inflows and a driver of economic progress, a phenomenon observed not only in Ghana but in various nations. The synergy between FDI and infrastructure development becomes evident, as enhanced infrastructure, encompassing transportation networks, energy systems, and communication facilities, is pivotal in attracting investments, bolstering productivity, and nurturing economic advancement. Existing research, including Lartey et al. (2016), has unveiled a positive correlation between financial development and infrastructure growth in Ghana. This connection underscores how an improved financial sector can catalyze physical infrastructure enhancements, such as roads, ports, and power generation, which in turn play a critical role in bolstering economic expansion and fostering further investments. Importantly, the data underscores that both economic growth rate and financial development exert a favorable influence on infrastructure development, reinforcing the principle that countries with robust economic growth rates and well-developed financial sectors tend to boast higher levels of infrastructure development. These conclusions, while anchored in available data and the employed model, offer valuable insights into the nexus between financial development and infrastructure advancement.

Objective 2 of the study focuses on exploring long and short term relationship between financial development and infrastructure development, in order to adopt a long term financial model for infrastructure financial in Ghana. The analysis of the data establishes a significant relationship between financial development and infrastructure development. The Granger causality test indicates that past values of financial development serve as predictors of changes in infrastructure development, highlighting the predictive power of financial development in explaining variations in infrastructure growth. This finding is reinforced by the threshold effect analysis, which demonstrates how alterations in financial development values correspond to substantial changes in infrastructure development, affirming financial development's role as a long-term financing model for infrastructure growth in Ghana. The error correction equation test under the VECM results also revealed that, the coefficient for the CointEq1 variable is 0.235374, indicating that there is a positive relationship between the deviation from the long-run equilibrium (as represented by CointEq1) and the change in IDI. This suggests that any deviation from the long-run equilibrium will be corrected by an adjustment in the IDI towards its equilibrium level. All the major testes carried out by FMOLS and VECM all point out to a long and short run relationship between financial development and infrastructure development as indicated by the data used.

Frimpong et al. (2022) emphasize the complexity and evolution of infrastructure financing models, shaped by economic conditions, policy priorities, and investment landscapes. In the context of Ghana, the analysis underscores the strong interconnection between infrastructure development and the financial sector's growth, suggesting that financial development serves as a key enabler of sustainable infrastructure growth.

Objective 3 of this study aimed to uncover the potential threshold effects of financial development on infrastructure development. In this regard, the investigation unveiled distinct threshold effects that manifested in the interaction between the dependent variable, IDI_F, and the threshold variable, IDI_F(-1). These effects were delineated through a segmentation of the data into three discrete threshold ranges, predicated on the varying values of IDI_F(-1). Remarkably, the analysis demonstrated the statistical significance of the coefficients of the independent variables—namely, economic growth, financial development, and Constant—within each of these threshold ranges, indicating their statistical significance at the 0.05 level of significance.

This statistical significance substantiates that the estimated impacts of these independent variables on IDI_F within each threshold range hold a substantial significance beyond chance occurrences. Delving further, the coefficient of financial development value provide a higher positive meaningful magnitude and direction of the effects exerted by the financial development on infrastructure development within each defined threshold range.

This econometric interpretation offers a nuanced comprehension of how alterations in one variable ripple through to influence IDI_F, thereby rendering a quantitative lens to the intricate relationship between these factors.

Consequently, the specific coefficient values illuminate the manner in which variations in the independent variables yield corresponding changes in IDI_F, depending on the delineated threshold range. This economic interpretation sheds light on the precise magnitude and nature of the impact, underscoring the reciprocal causation between these variables as the threshold variable traverses diverse ranges. This analytical strategy not only reinforces the understanding of the interrelation but also confers a dynamic perspective, revealing that the relationship between independent variables and the dependent variable isn't uniform across the entire spectrum. Rather, it undergoes pivotal shifts at these specific threshold points.

The recognition and elucidation of these threshold effects emerge as pivotal due to their capacity to illuminate the nuanced nature of the interplay between independent variables and the dependent variable. Particularly significant for policymakers and decision-makers, this revelation unveils distinct ranges within which different factors hold varying degrees of influence over the dependent variable. Such insight could drive the formulation of targeted and efficacious policies, optimizing outcomes across diverse ranges and enhancing the overall effectiveness of strategic decision-making. As such, the identification and analysis of these threshold effects contribute significantly to the depth of understanding and the precision of action in the realm of financial and infrastructural development.

# CHAPTER FIVE

# SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

## 5.0 Introduction

This chapter contains the summary of the findings, conclusions and recommendations. The discussion of results is summarized as findings based on study objectives, and conclusions were drawn according to the findings on each of the study objective. Recommendations were given based on the findings.

## 5.1 Summary of findings

The study's primary objective is to analyze the relationship between financial development and infrastructure development in Ghana, utilizing economic growth as a control variable. The analysis reveals that financial development significantly influences infrastructure development, as indicated by the Granger causality test, suggesting that past financial development values predict changes in infrastructure development. This underscores the role of financial development in shaping infrastructure improvements as measured by the Infrastructure Development Index (IDI), while economic growth (Y_F) also exhibit a significant direct impact on the relationship between financial development and infrastructure development. In the context of the Ghanaian economy, it's noted that financial development (FDI) is a crucial source of capital inflows, contributing to economic growth and infrastructure enhancement. There is positive correlation between financial development and physical infrastructure improvements, vital for attracting investment and fostering economic growth. The data further suggests that both economic growth rate and financial development have positive effects on infrastructure development, indicating that nations with stronger economic growth and financial sectors tend to exhibit higher levels of infrastructure development. Nonetheless, these conclusions are contingent on available data and the adopted model.

The second objective which deals with determining the short and long term relationship between financial development and infrastructure development in Ghana is realized through the data analysis presented above. The study establishes a significant and causal relationship between financial development and infrastructure development. The Granger causality test indicates that past values of financial development predict changes in infrastructure development, underscoring financial development's predictive influence. This Granger causality test result directly relate to a long-term relationship between the variables.

The coefficients values obtain through the cointegration test implied that both lagged IDI and FDI play important roles in determining the current level of infrastructure development, suggesting a long-run relationship between infrastructure development (IDI), financial development (FDI), and other factors.

Finally, the error correction equation test under the VECM results also revealed that, the coefficient for the CointEq1 variable is 0.235374, indicating that there is a positive relationship between the deviation from the long-run equilibrium (as represented by CointEq1) and the change in IDI. This suggests that any deviation from the long-run equilibrium will be corrected by an adjustment in the IDI towards its equilibrium level. All the major testes carried out by FMOLS and VECM all point out to a long and short run relationship between financial development and infrastructure development as indicated by the data used. Moreover, this findings is reinforced by the threshold effect, where increasing financial development values correspond to increased infrastructure development values. Frimpong et al. (2022) emphasize the intricate nature of infrastructure financing models, shaped by evolving economic conditions, policies, and investment landscapes. The analysis affirms the strong link between infrastructure development and financial sector development in Ghana, highlighting financial development as a pivotal long-term financing model. Despite the role of Foreign Direct Investment (FDI) recognized by the Ghanaian government in driving infrastructure development through policies promoting a conducive business environment and public-private partnerships, Totouom et al. (2019) emphasize the importance of considering diverse factors like domestic investment, government expenditure, and policy frameworks. Thus, a comprehensive analysis, adaptable to specific economic conditions, is crucial for a holistic understanding of infrastructure development dynamics in Ghana's economy.

Finally, the study's third objective also focuses on investigating the threshold effect of financial development on infrastructure development. The analysis identifies threshold effects in the relationship between the dependent variable, IDI_F, and the threshold variable, IDI_F(-1), categorizing data into three distinct threshold ranges based on IDI_F(-1) values. The coefficients of the independent variables (economic growth, financial development, and Constant) within each threshold range demonstrate statistical significance at the 0.05 level, suggesting that the estimated effects of these variables on IDI_F within each range are unlikely to be random occurrences. These coefficients offer insights into the extent and direction of the impacts of independent variables within specific threshold ranges, quantifying how changes in one variable influence another. Notably, these coefficients reveal the relationship between independent variables and the dependent variable as the threshold variable spans various ranges, allowing policymakers to discern where specific factors significantly affect the dependent variable. This understanding of threshold effects holds value for policy formulation, enabling tailored strategies that can optimize outcomes within each defined range. Financial development exhibit a high positive correlation coefficient across all the three (3) threshold intervals or ranges as 507.3629, 266.1110 and 260.9698 respectively. This result pointed out that the government of Ghana or policy makers to maintain financial development within the first threshold level if they really want to experience a high infrastructure growth in the country. The findings also indicates that more financial development can lead to a negative effect on infrastructure growth as indicated by the financial development coefficient which show a decline in the positive effect when financial development goes beyond certain levels.

## 5.2 Implications of the study

The study's findings highlight the critical role of financial development in driving infrastructure development. Policymakers can use this insight to prioritize policies that promote a robust financial sector, which in turn can contribute to sustainable infrastructure growth. Moreover, the study's identification of causality relationships between financial development and infrastructure development can guide policy decisions aimed at fostering economic growth through strategic investment in both sectors.

Investors and fund managers can leverage the study's results to make informed decisions about allocating resources for infrastructure projects. Understanding the significant linkage between financial development and infrastructure growth can guide investment strategies that capitalize on these interconnected sectors to maximize returns and contribute to broader economic development.

The study's findings can inform strategies for rural development. As infrastructure development is crucial for improving living standards in rural areas, policymakers can prioritize initiatives that enhance financial development in these regions. By addressing infrastructure deficits and facilitating access to financial services, rural development can be effectively promoted.

Banking and financial institutions can benefit from the study's insights by aligning their services with infrastructure development needs. The correlation between financial development and infrastructure growth emphasizes the importance of a strong financial sector in providing the necessary capital for infrastructure projects. Financial institutions can tailor their products to support infrastructure financing and investment.

The study's identification of financial development as a long-term financing model for infrastructure has implications for sustainable development. By fostering a robust financial sector, countries can create a sustainable foundation for funding infrastructure projects that address current and future needs, contributing to overall economic growth and development.

### 5.3 Conclusion

In conclusion, the study delved into the effects of financial development on infrastructure development in Ghana. The study synergized and qualitatively explored financial development impact on infrastructure development and the level of influence a well-developed financial sector on the development of infrastructure in Ghana. The study employed quantitative research design as the methodology. These models allows for the synchronization of these data using time series model spanning a 30 year period from 1990 to 2020. The study basically relied on descriptive statistics in the analysis of the data. The data suggests that there is a positive and statistically significant relationship between the Financial Development (FDI) and the Infrastructure Development (IDI) established using the Granger Causality test, this findings leads to the full achievement of the main objective (1) of the study. The second objective was achieve through the establishment of a short and long-term relationship between the two variables of interest as established in the Full modified ordinary least squares and the vector error correction model analysis. This indicated that financial development has a predictive power in explaining variations in infrastructure development. This finding implies that financial development plays a huge role in influencing infrastructure development. Also, this has also been established in the threshold effect. The findings in discrete threshold regression suggests that there are meaningful relationships between the variables, which have both statistical and practical significance. This finding also attributed to the achievement of the third objective in the study.

## 5.4 Recommendations

These recommendations emphasize the need for a deeper understanding of the cointegrating relationship and the consideration of both long-term and short-term dynamics of other variables related to infrastructure development and financial development. Further analysis, interpretation, and contextualization of the results can contribute to more informed decision-making and a better understanding of these macroeconomic variables.

Secondly, future studies should consider conducting a sector-specific analysis focusing on a particular area of infrastructure development in Ghana, such as transportation, energy, or telecommunications. This would allow for a more targeted examination of the financing models and their implications within specific sector in the economy.

Thirdly, future supplement the quantitative analysis with qualitative research methods, such as interviews or surveys, to gather insights from key stakeholders involved in infrastructure development and financing in Ghana. Their perspectives can provide valuable context and shed light on the practical aspects of financing models, policy implications, and potential barriers or challenges.

Fourthly, explore causal relationships between the independent variables and the dependent variable by employing techniques like instrumental variables or propensity score matching. This can help to establish a more robust causal link between the variables of interest. While previous studies have explored the relationship between financial sector development and infrastructure in Africa, it is crucial to conduct more country-specific research, such as focusing on Ghana. This will allow for a deeper understanding of the unique factors affecting Ghana's financial sector and its impact on infrastructure development.

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APPENDIX

Mean distribution of variables

| Year | Y (Economic Growth rate) | FDI | IDI |
|---|---|---|---|
| 1990 | -2.1 | 0.12 | 3.345660 |
| 1991 | -2.1 | 0.11 | 3.943530 |
| 1992 | -0.9 | 0.09 | 4.123550 |
| 1993 | -1.3 | 0.10 | 4.633340 |
| 1994 | 3.1 | 0.13 | 4.934540 |
| 1995 | 4.9 | 0.10 | 5.457650 |
| 1996 | 4.6 | 0.10 | 5.756530 |
| 1997 | 3.7 | 0.11 | 6.678430 |
| 1998 | 4.2 | 0.11 | 7.346560 |
| 1999 | 3.7 | 0.11 | 8.234550 |
| 2000 | 3.7 | 0.11 | 8.565640 |
| 2001 | 4.0 | 0.12 | 8.945450 |
| 2002 | 4.3 | 0.11 | 9.234830 |
| 2003 | 5.2 | 0.11 | 9.874550 |
| 2004 | 5.8 | 0.14 | 10.45960 |
| 2005 | 5.9 | 0.12 | 10.87140 |
| 2006 | 6.6 | 0.11 | 11.29220 |
| 2007 | 6.3 | 0.12 | 12.95580 |
| 2008 | 8.4 | 0.13 | 12.21770 |
| 2009 | 4.0 | 0.11 | 14.19560 |
| 2010 | 8.0 | 0.12 | 14.70000 |
| 2011 | 14.4 | 0.13 | 19.36830 |
| 2012 | 7.8 | 0.15 | 19.57540 |
| 2013 | 7.3 | 0.15 | 25.43520 |
| 2014 | 4.0 | 0.16 | 23.75350 |
| 2015 | 3.9 | 0.16 | 21.10760 |
| 2016 | 3.4 | 0.17 | 26.09740 |
| 2017 | 8.1 | 0.17 | 27.38370 |
| 2018 | 6.3 | 0.16 | 28.83500 |
| 2019 | 6.1 | 0.17 | 29.51380 |
| 2020 | 0.4 | 0.17 | 30.12580 |

**Augmented Dickey-Fuller Unit Root Test on Y__ECONOMIC_GROWTH_RATE_**

Null Hypothesis: Y__ECONOMIC_GROWTH_RATE_ has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -2.749234 | 0.0778 |
| Test critical values: | 1% level | -3.670170 | |
| | 5% level | -2.963972 | |
| | 10% level | -2.621007 | |

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(Y__ECONOMIC_GROWTH_RATE_)
Method: Least Squares
Date: 05/29/23 Time: 18:28
Sample (adjusted): 1991 2020
Included observations: 30 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| Y__ECONOMIC_GROWTH_RATE_( | -0.377281 | 0.137231 | -2.749234 | 0.0103 |
| C | 1.860327 | 0.790469 | 2.353447 | 0.0259 |

| | | | |
|---|---|---|---|
| R-squared | 0.212561 | Mean dependent var | 0.083333 |
| Adjusted R-squared | 0.184438 | S.D. dependent var | 2.759821 |
| S.E. of regression | 2.492352 | Akaike info criterion | 4.728671 |
| Sum squared resid | 173.9309 | Schwarz criterion | 4.822084 |
| Log likelihood | -68.93007 | Hannan-Quinn criter. | 4.758555 |
| F-statistic | 7.558290 | Durbin-Watson stat | 1.996373 |
| Prob(F-statistic) | 0.010341 | | |

**Augmented Dickey-Fuller Unit Root Test on Y__ECONOMIC_GROWTH_RATE_**

Null Hypothesis: Y__ECONOMIC_GROWTH_RATE_ has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -2.749234 | 0.0778 |
| Test critical values: | 1% level | -3.670170 | |
| | 5% level | -2.963972 | |
| | 10% level | -2.621007 | |

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(Y__ECONOMIC_GROWTH_RATE_)
Method: Least Squares
Date: 06/01/23 Time: 22:39
Sample (adjusted): 1991 2020
Included observations: 30 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| Y__ECONOMIC_GROWTH_RATE_( | -0.377281 | 0.137231 | -2.749234 | 0.0103 |
| C | 1.860327 | 0.790469 | 2.353447 | 0.0259 |

| | | | |
|---|---|---|---|
| R-squared | 0.212561 | Mean dependent var | 0.083333 |
| Adjusted R-squared | 0.184438 | S.D. dependent var | 2.759821 |
| S.E. of regression | 2.492352 | Akaike info criterion | 4.728671 |
| Sum squared resid | 173.9309 | Schwarz criterion | 4.822084 |
| Log likelihood | -68.93007 | Hannan-Quinn criter. | 4.758555 |
| F-statistic | 7.558290 | Durbin-Watson stat | 1.996373 |
| Prob(F-statistic) | 0.010341 | | |

**Augmented Dickey-Fuller Unit Root Test on FDI**

Null Hypothesis: FDI has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.085929 | 0.7081 |
| Test critical values: | 1% level | -3.670170 | |
| | 5% level | -2.963972 | |
| | 10% level | -2.621007 | |

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(FDI)
Method: Least Squares
Date: 05/15/23 Time: 18:10
Sample (adjusted): 1991 2020
Included observations: 30 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| FDI(-1) | -0.117409 | 0.108118 | -1.085929 | 0.2868 |
| C | 0.016538 | 0.013927 | 1.187487 | 0.2450 |

| | | | |
|---|---|---|---|
| R-squared | 0.040414 | Mean dependent var | 0.001667 |
| Adjusted R-squared | 0.006143 | S.D. dependent var | 0.013917 |
| S.E. of regression | 0.013874 | Akaike info criterion | -5.653257 |
| Sum squared resid | 0.005390 | Schwarz criterion | -5.559844 |
| Log likelihood | 86.79885 | Hannan-Quinn criter. | -5.623373 |
| F-statistic | 1.179243 | Durbin-Watson stat | 2.288607 |
| Prob(F-statistic) | 0.286771 | | |

**Augmented Dickey-Fuller Unit Root Test on IDI**

Null Hypothesis: IDI has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | 0.499397 | 0.9838 |
| Test critical values: | 1% level | -3.670170 | |
| | 5% level | -2.963972 | |
| | 10% level | -2.621007 | |

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(IDI)
Method: Least Squares
Date: 05/15/23 Time: 18:01
Sample (adjusted): 1991 2020
Included observations: 30 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| IDI(-1) | 0.019264 | 0.038575 | 0.499397 | 0.6214 |
| C | 0.636563 | 0.601461 | 1.058363 | 0.2989 |

| | | | |
|---|---|---|---|
| R-squared | 0.008828 | Mean dependent var | 0.892671 |
| Adjusted R-squared | -0.026571 | S.D. dependent var | 1.698817 |
| S.E. of regression | 1.721238 | Akaike info criterion | 3.988305 |
| Sum squared resid | 82.95451 | Schwarz criterion | 4.081719 |
| Log likelihood | -57.82458 | Hannan-Quinn criter. | 4.018189 |
| F-statistic | 0.249397 | Durbin-Watson stat | 2.677940 |
| Prob(F-statistic) | 0.621402 | | |

**Phillips-Perron Unit Root Test on Y__ECONOMIC_GROWTH_RATE_**

Null Hypothesis: Y__ECONOMIC_GROWTH_RATE_ has a unit root
Exogenous: Constant
Bandwidth: 6 (Newey-West automatic) using Bartlett kernel

| | | Adj. t-Stat | Prob.* |
|---|---|---|---|
| Phillips-Perron test statistic | | -2.547752 | 0.1149 |
| Test critical values: | 1% level | -3.670170 | |
| | 5% level | -2.963972 | |
| | 10% level | -2.621007 | |

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

| | |
|---|---|
| Residual variance (no correction) | 5.797698 |
| HAC corrected variance (Bartlett kernel) | 3.780712 |

Phillips-Perron Test Equation
Dependent Variable: D(Y__ECONOMIC_GROWTH_RATE_)
Method: Least Squares
Date: 07/10/23 Time: 15:07
Sample (adjusted): 1991 2020
Included observations: 30 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| Y__ECONOMIC_GROWTH_RATE_( | -0.377281 | 0.137231 | -2.749234 | 0.0103 |
| C | 1.860327 | 0.790469 | 2.353447 | 0.0259 |

| | | | |
|---|---|---|---|
| R-squared | 0.212561 | Mean dependent var | 0.083333 |
| Adjusted R-squared | 0.184438 | S.D. dependent var | 2.759821 |
| S.E. of regression | 2.492352 | Akaike info criterion | 4.728671 |
| Sum squared resid | 173.9309 | Schwarz criterion | 4.822084 |
| Log likelihood | -68.93007 | Hannan-Quinn criter. | 4.758555 |
| F-statistic | 7.558290 | Durbin-Watson stat | 1.996373 |
| Prob(F-statistic) | 0.010341 | | |

**Phillips-Perron Unit Root Test on FDI**

Null Hypothesis: FDI has a unit root
Exogenous: Constant
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

| | | Adj. t-Stat | Prob.* |
|---|---|---|---|
| Phillips-Perron test statistic | | -1.085929 | 0.7081 |
| Test critical values: | 1% level | -3.670170 | |
| | 5% level | -2.963972 | |
| | 10% level | -2.621007 | |

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

| | |
|---|---|
| Residual variance (no correction) | 0.000180 |
| HAC corrected variance (Bartlett kernel) | 0.000180 |

Phillips-Perron Test Equation
Dependent Variable: D(FDI)
Method: Least Squares
Date: 07/10/23 Time: 15:37
Sample (adjusted): 1991 2020
Included observations: 30 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| FDI(-1) | -0.117409 | 0.108118 | -1.085929 | 0.2868 |
| C | 0.016538 | 0.013927 | 1.187487 | 0.2450 |

| | | | |
|---|---|---|---|
| R-squared | 0.040414 | Mean dependent var | 0.001667 |
| Adjusted R-squared | 0.006143 | S.D. dependent var | 0.013917 |
| S.E. of regression | 0.013874 | Akaike info criterion | -5.653257 |
| Sum squared resid | 0.005390 | Schwarz criterion | -5.559844 |
| Log likelihood | 86.79885 | Hannan-Quinn criter. | -5.623373 |
| F-statistic | 1.179243 | Durbin-Watson stat | 2.288607 |
| Prob(F-statistic) | 0.286771 | | |

**Phillips-Perron Unit Root Test on IDI**

Null Hypothesis: IDI has a unit root
Exogenous: Constant
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

| | | Adj. t-Stat | Prob.* |
|---|---|---|---|
| Phillips-Perron test statistic | | 1.313131 | 0.9981 |
| Test critical values: | 1% level | -3.670170 | |
| | 5% level | -2.963972 | |
| | 10% level | -2.621007 | |

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

| | |
|---|---|
| Residual variance (no correction) | 2.765150 |
| HAC corrected variance (Bartlett kernel) | 1.113514 |

Phillips-Perron Test Equation
Dependent Variable: D(IDI)
Method: Least Squares
Date: 07/10/23 Time: 15:36
Sample (adjusted): 1991 2020
Included observations: 30 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| IDI(-1) | 0.019264 | 0.038575 | 0.499397 | 0.6214 |
| C | 0.6365630.6014611.0583630.2989 | | | |

| | | | |
|---|---|---|---|
| R-squared | 0.008828 | Mean dependent var | 0.892671 |
| Adjusted R-squared | -0.026571 | S.D. dependent var | 1.698817 |
| S.E. of regression | 1.721238 | Akaike info criterion | 3.988305 |
| Sum squared resid | 82.95451 | Schwarz criterion | 4.081719 |
| Log likelihood | -57.82458 | Hannan-Quinn criter. | 4.018189 |
| F-statistic | 0.249397 | Durbin-Watson stat | 2.677940 |
| Prob(F-statistic) | 0.621402 | | |

**FMOLS**

Dependent Variable: IDI
Method: Fully Modified Least Squares (FMOLS)
Date: 05/29/23 Time: 17:49
Sample (adjusted): 1991 2020
Included observations: 30 after adjustments
Cointegrating equation deterministics: C
Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| Y__ECONOMIC_GROWTH_RAT | 0.420817 | 0.152968 | 2.751006 | 0.0105 |
| FDI | 324.1121 | 19.69042 | 16.46040 | 0.0000 |
| C | -29.32035 | 2.479856 | -11.82341 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.851812 | Mean dependent var | 14.18724 |
| Adjusted R-squared | 0.840835 | S.D. dependent var | 8.613187 |
| S.E. of regression | 3.436275 | Sum squared resid | 318.8157 |
| Long-run variance | 6.556780 | | |

**Pairwise Granger Causality Tests**
**Date: 06/01/23 Time: 23:14**
**Sample: 1990 2020**
**Lags: 2**

| Null Hypothesis: | Obs | F-Statistic | Prob. |
|---|---|---|---|
| Y__ECONOMIC_GROWTH_RATE__F does not Granger Cause IDI_F | 26 | 1925.18 | 2.E-24 |
| IDI_F does not Granger Cause Y__ECONOMIC_GROWTH_RATE__F | | 1578.51 | 1.E-23 |
| FDI_F does not Granger Cause IDI_F | 26 | 1673.71 | 7.E-24 |
| IDI_F does not Granger Cause FDI_F | | 4666.31 | 2.E-28 |
| FDI_F does not Granger Cause Y__ECONOMIC_GROWTH_RATE__F | 26 | 517.732 | 1.E-18 |
| Y__ECONOMIC_GROWTH_RATE__F does not Granger Cause FDI_F | | 185.233 | 5.E-14 |

**FMOLS 1**

Dependent Variable: IDI
Method: Fully Modified Least Squares (FMOLS)
Date: 05/29/23 Time: 17:49
Sample (adjusted): 1991 2020
Included observations: 30 after adjustments
Cointegrating equation deterministics: C
Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| Y__ECONOMIC_GROWTH_RAT | 0.420817 | 0.152968 | 2.751006 | 0.0105 |
| FDI | 324.1121 | 19.69042 | 16.46040 | 0.0000 |
| C | -29.32035 | 2.479856 | -11.82341 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.851812 | Mean dependent var | 14.18724 |
| Adjusted R-squared | 0.840835 | S.D. dependent var | 8.613187 |
| S.E. of regression | 3.436275 | Sum squared resid | 318.8157 |
| Long-run variance | 6.556780 | | |

**Johansen Cointegration Test**

Date: 05/29/23 Time: 18:37
Sample (adjusted): 1993 2020
Included observations: 28 after adjustments
Trend assumption: Linear deterministic trend
Series: IDI FDI Y__ECONOMIC_GROWTH_RATE_
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None * | 0.452461 | 30.01795 | 29.79707 | 0.0472 |
| At most 1 | 0.374726 | 13.15295 | 15.49471 | 0.1093 |
| At most 2 | 0.000182 | 0.005107 | 3.841465 | 0.9421 |

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
C denotes rejection of the hypothesis
at the 0.05 level **MacKinnon-Haug-
Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

| Hypothesized No. of CE(s) | Eigenvalue | Max-Eigen Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None | 0.452461 | 16.86500 | 21.13162 | 0.1785 |
| At most 1 | 0.374726 | 13.14784 | 14.26460 | 0.0745 |
| At most 2 | 0.000182 | 0.005107 | 3.841465 | 0.9421 |

Max-eigenvalue test indicates no cointegration at the 0.05 level
C denotes rejection of the hypothesis
at the 0.05 level **MacKinnon-Haug-
Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

| IDI | FDI | Y__ECONOMIC_GROWTH_RATE_ |
|---|---|---|
| -0.691572 | 219.2788 | 0.101786 |
| -0.426843 | 153.7196 | 0.538337 |
| -0.169785 | 2.284779 | 0.339164 |

Unrestricted Adjustment Coefficients (alpha):

| | | | |
|---|---|---|---|
| D(IDI) | -0.340347 | 0.584543 | -0.015939 |
| D(FDI) | -0.006020 | -0.002203 | -1.02E-05 |
| D(Y__ECON | 0.597515 | -0.835156 | -0.026075 |

1 Cointegrating Equation(s): Log likelihood -19.42726

Normalized cointegrating coefficients (standard error in parentheses)

| IDI | FDI | Y__ECONOMIC_GROWTH_RATE_ |
|---|---|---|
| 1.000000 | -317.0730 | -0.147180 |
| (19.4620) | | (0.17040) |

Adjustment coefficients (standard error in parentheses
D(IDI) 0.235374 (0.24181) D(FDI) 0.004163 (0.00117) D(Y) 0.413222

**Johansen Cointegration Test**

| | | | |
|---|---|---|---|
| **2 Cointegrating Equation(s):** | | **Log likelihood** | **-12.85334** |
| **Normalized cointegrating coefficients (standard error in parentheses)** | | | |
| **IDI** | **FDI** | **Y__ECONOMIC_GROWTH_RATE_** | |
| **1.000000** | **0.000000** | **8.056243** | |
| | | **(2.67581)** | |
| **0.000000** | **1.000000** | **0.025872** | |
| | | **(0.00819)** | |
| **Adjustment coefficients (standard error in parentheses)** | | | |
| **D(IDI)** | **-0.014134** | **15.22484** | |
| **(0.26355)** | | **(86.8445)** | |
| **D(FDI)** | **0.005103** | **-1.658583** | |
| **(0.00132)** | | **(0.43395)** | |
| **D(Y__ECON** | | **-0.056744** | **2.642527** |
| **(0.41931)** | | **(138.169)** | |

Dependent Variable: IDI_F
Method: Discrete Threshold Regression
Date: 06/02/23 Time: 11:48
Sample (adjusted): 1994 2020
Included observations: 27 after adjustments
Selection: Trimming 0.15, Max. thresholds 5, Sig. level 0.05
Threshold variable: IDI_F(-1)

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| IDI_F(-1) < 8.559517 -- 4 obs | | | | |
| Y__ECONOMIC_GROWTH_RATE_ | -5.487357 | 0.052591 | -104.3395 | 0.0000 |
| FDI_F | 507.3629 | 5.635902 | 90.02337 | 0.0000 |
| C | -43.40545 | 0.580011 | -74.83554 | 0.0000 |
| 8.559517 <= IDI_F(-1) < 13.56247 -- 5 obs | | | | |
| Y__ECONOMIC_GROWTH_RATE_ | -2.750269 | 0.073714 | -37.31008 | 0.0000 |
| FDI_F | 266.1110 | 2.383150 | 111.6635 | 0.0000 |
| C | -18.69768 | 0.327508 | -57.09085 | 0.0000 |
| 13.56247 <= IDI_F(-1) -- 18 obs | | | | |
| Y__ECONOMIC_GROWTH_RATE_ | -2.303049 | 0.318596 | -7.228751 | 0.0000 |
| FDI_F | 260.9698 | 7.223584 | 36.12747 | 0.0000 |
| C | -18.32280 | 1.123293 | -16.31169 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.999996 | Mean dependent var | 18.38255 |
| Adjusted R-squared | 0.999995 | S.D. dependent var | 7.638100 |
| S.E. of regression | 0.017581 | Akaike info criterion | -4.982746 |
| Sum squared resid | 0.005564 | Schwarz criterion | -4.550801 |
| Log likelihood | 76.26708 | Hannan-Quinn criter. | -4.854306 |
| F-statistic | 613400.9 | Durbin-Watson stat | 3.218069 |
| Prob(F-statistic) | 0.000000 | | |

**Vector Autoregression Estimates**

Vector Autoregression Estimates
Date: 05/29/23 Time: 18:34
Sample (adjusted): 1992 2020
Included observations: 29 after adjustments
Standard errors in ( ) & t-statistics in [ ]

| | IDI | FDI | Y__ECONOM |
|---|---|---|---|
| IDI(-1) | 0.589231 | 0.003467 | 0.216897 |
| | (0.21191) | (0.00112) | (0.32299) |
| | [ 2.78054] | [ 3.08304] | [ 0.67152] |
| IDI(-2) | 0.390275 | 0.001042 | -0.112036 |
| | (0.22424) | (0.00119) | (0.34178) |
| | [ 1.74045] | [ 0.87575] | [-0.32780] |
| FDI(-1) | 15.48763 | -0.079657 | -8.937540 |
| | (35.7931) | (0.18995) | (54.5554) |
| | [ 0.43270] | [-0.41936] | [-0.16383] |
| FDI(-2) | -5.369417 | -0.452527 | -43.53100 |
| | (33.4007) | (0.17725) | (50.9089) |
| | [-0.16076] | [-2.55301] | [-0.85508] |
| Y__ECONOMIC_GROW | 0.121381 | -0.001081 | 0.443470 |
| | (0.15557) | (0.00083) | (0.23711) |
| | [ 0.78026] | [-1.30915] | [ 1.87031] |
| Y__ECONOMIC_GROW | 0.057574 | -0.000300 | 0.090798 |
| | (0.14959) | (0.00079) | (0.22801) |
| | [ 0.38487] | [-0.37735] | [ 0.39822] |
| C | -0.627351 | 0.141903 | 7.466720 |
| | (4.71495) | (0.02502) | (7.18646) |
| | [-0.13306] | [ 5.67123] | [ 1.03900] |
| R-squared | 0.967317 | 0.894770 | 0.386140 |
| Adj. R-squared | 0.958403 | 0.866070 | 0.218723 |
| Sum sq. resids | 66.76797 | 0.001880 | 155.1115 |
| S.E. equation | 1.742099 | 0.009245 | 2.655282 |
| F-statistic | 108.5208 | 31.17749 | 2.306462 |
| Log likelihood | -53.24117 | 98.68281 | -65.46352 |
| Akaike AIC | 4.154563 | -6.322953 | 4.997484 |
| Schwarz SC | 4.484600 | -5.992916 | 5.327521 |
| Mean dependent | 14.54047 | 0.128966 | 5.031034 |
| S.D. dependent | 8.541644 | 0.025262 | 3.004057 |
| Determinant resid covariance (dof adj.) | | 0.001524 | |
| Determinant resid covariance | | 0.000665 | |
| Log likelihood | | -17.37616 | |
| Akaike information criterion | | 2.646631 | |
| Schwarz criterion | | 3.636742 | |
| Number of coefficients | | 21 | |

## Vector Error Correction Estimates

Vector Error Correction Estimates
Date: 05/29/23 Time: 18:47
Sample (adjusted): 1993 2020
Included observations: 28 after adjustments
Standard errors in ( ) & t-statistics in [ ]

| Cointegrating Eq: | CointEq1 |
|---|---|
| IDI(-1) | 1.000000 |
| FDI(-1) | -317.0730<br>(19.4620)<br>[-16.2919] |
| Y__ECONOMIC_GROW | -0.147180<br>(0.17040)<br>[-0.86374] |
| C | 27.20776 |

| Error Correction: | D(IDI) | D(FDI) | D(Y__ECON |
|---|---|---|---|
| CointEq1 | 0.235374<br>(0.24181)<br>[ 0.97340] | 0.004163<br>(0.00117)<br>[ 3.55411] | -0.413225<br>(0.37947)<br>[-1.08894] |
| D(IDI(-1)) | -0.595367<br>(0.33378)<br>[-1.78374] | -0.002033<br>(0.00162)<br>[-1.25722] | 0.261622<br>(0.52380)<br>[ 0.49947] |
| D(IDI(-2)) | -0.270475<br>(0.25935)<br>[-1.04291] | -0.002519<br>(0.00126)<br>[-2.00489] | -0.228353<br>(0.40700)<br>[-0.56106] |
| D(FDI(-1)) | 65.83786<br>(52.3292)<br>[ 1.25815] | 0.345166<br>(0.25348)<br>[ 1.36170] | -77.65974<br>(82.1216)<br>[-0.94567] |
| D(FDI(-2)) | 26.80161<br>(36.5805)<br>[ 0.73267] | -0.109580<br>(0.17720)<br>[-0.61841] | -88.70562<br>(57.4069)<br>[-1.54521] |
| D(Y__ECONOMIC_GR | 0.053550<br>(0.15048)<br>[ 0.35587] | 0.000187<br>(0.00073)<br>[ 0.25679] | -0.341955<br>(0.23615)<br>[-1.44807] |
| D(Y__ECONOMIC_GR | 0.104220<br>(0.14595)<br>[ 0.71410] | 0.000665<br>(0.00071)<br>[ 0.94088] | -0.109588<br>(0.22904)<br>[-0.47848] |
| C | 1.4922600.0061690.441543<br>(0.50969)<br>[ 2.92778] | (0.00247)<br>[ 2.49858] | (0.79987)<br>[ 0.55202] |
| R-squared | 0.175777 | 0.676874 | 0.232171 |
| Adj. R-squared | -0.112701 | 0.563779 | -0.036569 |
| Sum sq. resids | 68.46189 | 0.001606 | 168.6072 |
| S.E. equation | 1.850161 | 0.008962 | 2.903508 |
| F-statistic | 0.609326 | 5.985038 | 0.863926 |
| Log likelihood | -52.24730 | 96.99322 | -64.86542 |

| | | | |
|---|---|---|---|
| **Akaike AIC** | **4.303378** | **-6.356658** | **5.204673** |
| **Schwarz SC** | **4.684008** | **-5.976029** | **5.585303** |
| **Mean dependent** | **0.928652** | **0.002857** | **0.046429** |
| **S.D. dependent** | **1.753962** | **0.013569** | **2.851833** |

**Vector Error Correction Estimates**

| | |
|---|---|
| Determinant resid covariance (dof adj.) | 0.002206 |
| Determinant resid covariance | 0.000804 |
| Log likelihood | -19.42726 |
| Akaike information criterion | 3.316233 |
| Schwarz criterion | 4.600858 |
| Number of coefficients | 27 |

## Vector Error Correction Estimates

Vector Error Correction Estimates
Date: 05/29/23 Time: 18:45
Sample (adjusted): 1993 2020
Included observations: 28 after adjustments
Standard errors in ( ) & t-statistics in [ ]

| Cointegrating Eq: | CointEq1 |
|---|---|
| IDI(-1) | 1.000000 |
| FDI(-1) | -317.0730 |
| | (19.4620) |
| | [-16.2919] |
| Y__ECONOMIC_GROW | -0.147180 |
| | (0.17040) |
| | [-0.86374] |
| C | 27.20776 |

| Error Correction: | D(IDI) | D(FDI) | D(Y__ECON |
|---|---|---|---|
| CointEq1 | 0.235374 | 0.004163 | -0.413225 |
| | (0.24181) | (0.00117) | (0.37947) |
| | [ 0.97340] | [ 3.55411] | [-1.08894] |
| D(IDI(-1)) | -0.595367 | -0.002033 | 0.261622 |
| | (0.33378) | (0.00162) | (0.52380) |
| | [-1.78374] | [-1.25722] | [ 0.49947] |
| D(IDI(-2)) | -0.270475 | -0.002519 | -0.228353 |
| | (0.25935) | (0.00126) | (0.40700) |
| | [-1.04291] | [-2.00489] | [-0.56106] |
| D(FDI(-1)) | 65.83786 | 0.345166 | -77.65974 |
| | (52.3292) | (0.25348) | (82.1216) |
| | [ 1.25815] | [ 1.36170] | [-0.94567] |
| D(FDI(-2)) | 26.80161 | -0.109580 | -88.70562 |
| | (36.5805) | (0.17720) | (57.4069) |
| | [ 0.73267] | [-0.61841] | [-1.54521] |
| D(Y__ECONOMIC_GR | 0.053550 | 0.000187 | -0.341955 |
| | (0.15048) | (0.00073) | (0.23615) |
| | [ 0.35587] | [ 0.25679] | [-1.44807] |
| D(Y__ECONOMIC_GR | 0.104220 | 0.000665 | -0.109588 |
| | (0.14595) | (0.00071) | (0.22904) |
| | [ 0.71410] | [ 0.94088] | [-0.47848] |
| C | 1.4922600.0061690.441543 | | |
| | (0.50969) | (0.00247) | (0.79987) |
| | [ 2.92778] | [ 2.49858] | [ 0.55202] |
| R-squared | 0.175777 | 0.676874 | 0.232171 |
| Adj. R-squared | -0.112701 | 0.563779 | -0.036569 |

| | | | |
|---|---|---|---|
| **Sum sq. resids** | **68.46189** | **0.001606** | **168.6072** |
| **S.E. equation** | **1.850161** | **0.008962** | **2.903508** |
| **F-statistic** | **0.609326** | **5.985038** | **0.863926** |
| **Log likelihood** | **-52.24730** | **96.99322** | **-64.86542** |
| **Akaike AIC** | **4.303378** | **-6.356658** | **5.204673** |
| **Schwarz SC** | **4.684008** | **-5.976029** | **5.585303** |
| **Mean dependent** | **0.928652** | **0.002857** | **0.046429** |
| **S.D. dependent** | **1.753962** | **0.013569** | **2.851833** |

**Vector Error Correction Estimates**

| | |
|---|---|
| Determinant resid covariance (dof adj.) | 0.002206 |
| Determinant resid covariance | 0.000804 |
| Log likelihood | -19.42726 |
| Akaike information criterion | 3.316233 |
| Schwarz criterion | 4.600858 |
| Number of coefficients | 27 |

Dependent Variable: FDI
Method: Canonical Cointegrating Regression (CCR)
Date: 05/15/23 Time: 17:21
Sample (adjusted): 1991 2020
Included observations: 30 after adjustments
Cointegrating equation deterministics: C
Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwid = 4.0000)

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| IDI | 0.002756 | 0.000199 | 13.84658 | 0.0000 |
| C | 0.090385 | 0.003073 | 29.41658 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.839863 | Mean dependent var | 0.128333 |
| Adjusted R-squared | 0.834143 | S.D. dependent var | 0.025063 |
| S.E. of regression | 0.010207 | Sum squared resid | 0.002917 |
| Long-run variance | 7.80E-05 | | |

**Pairwise Granger Causality Tests**
**Date: 05/15/23 Time: 18:25**
**Sample: 1990 2020**
**Lags: 3**

| Null Hypothesis: | Obs | F-Statistic | Prob. |
|---|---|---|---|
| FDI_F does not Granger Cause IDI_F | 25 | 1.5E+19 | 1E-165 |
| IDI_F does not Granger Cause FDI_F | | 1.7E+19 | 4E-166 |

Pairwise Granger Causality Tests
Date: 05/15/23 Time: 18:21
Sample: 1990 2020
Lags: 2

| Null Hypothesis: | Obs | F-Statistic | Prob. |
|---|---|---|---|
| FDI_F does not Granger Cause IDI_F | 26 | 6833.79 | 3.E-30 |
| IDI_F does not Granger Cause FDI_F | | 4200.57 | 5.E-28 |

Dependent Variable: FDI
Method: Discrete Threshold Regression
Date: 05/15/23 Time: 17:31
Sample (adjusted): 1993 2020
Included observations: 28 after adjustments
No thresholds selected
Selection: Trimming 0.15, Max. thresholds 5, Sig. level 0.05

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| IDI | 0.002659 | 0.000230 | 11.57292 | 0.0000 |
| C | 0.090708 | 0.0039212 | 3.13169 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.837432 | Mean dependent var | 0.130357 |
| Adjusted R-squared | 0.831179 | S.D. dependent var | 0.024568 |
| S.E. of regression | 0.010094 | Akaike info criterion | -6.284935 |
| Sum squared resid | 0.002649 | Schwarz criterion | -6.189778 |
| Log likelihood | 89.98910 | Hannan-Quinn criter. | -6.255845 |
| F-statistic | 133.9326 | Durbin-Watson stat | 2.091010 |
| Prob(F-statistic) | 0.000000 | | |

Dependent Variable: FDI
Method: Discrete Threshold Regression
Date: 05/15/23 Time: 17:28
Sample (adjusted): 1994 2020
Included observations: 27 after adjustments
No thresholds selected
Selection: Trimming 0.15, Max. thresholds 5, Sig. level 0.05

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| IDI | 0.002641 | 0.000241 | 10.96884 | 0.0000 |
| C | 0.091091 | 0.004180 | 21.79387 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.827960 | Mean dependent var | 0.131481 |
| Adjusted R-squared | 0.821079 | S.D. dependent var | 0.024291 |
| S.E. of regression | 0.010275 | Akaike info criterion | -6.247086 |
| Sum squared resid | 0.002639 | Schwarz criterion | -6.151098 |
| Log likelihood | 86.33566 | Hannan-Quinn criter. | -6.218544 |
| F-statistic | 120.3155 | Durbin-Watson stat | 1.772818 |
| Prob(F-statistic) | 0.000000 | | |

**Vector Error Correction Estimates**

Vector Error Correction Estimates
Date: 05/15/23 Time: 17:13
Sample (adjusted): 1993 2020
Included observations: 28 after adjustments
Standard errors in ( ) & t-statistics in [ ]

| Cointegrating Eq: | CointEq1 | |
|---|---|---|
| FDI(-1) | 1.000000 | |
| IDI(-1) | -0.003008 | |
| | (0.00020) | |
| | [-15.2569] | |
| C | -0.085434 | |
| **Error Correction:** | **D(FDI)** | **D(IDI)** |
| CointEq1 | -1.190225 | -69.02608 |
| | (0.33798) | (67.5675) |
| | [-3.52158] | [-1.02159] |
| D(FDI(-1)) | 0.244541 | 60.21562 |
| | (0.23388) | (46.7560) |
| | [ 1.04559] | [ 1.28787] |
| D(FDI(-2)) | -0.161097 | 25.32081 |
| | (0.16740) | (33.4658) |
| | [-0.96235] | [ 0.75662] |
| D(IDI(-1)) | -0.001632 | -0.570117 |
| | (0.00151) | (0.30106) |
| | [-1.08355] | [-1.89369] |
| D(IDI(-2)) | -0.002168 | -0.241751 |
| | (0.00121) | (0.24117) |
| | [-1.79710] | [-1.00239] |
| C | 0.0060271.504164 | |
| | (0.00245) | (0.48911) |
| | [ 2.46342] | [ 3.07528] |
| R-squared | 0.650723 | 0.164514 |
| Adj. R-squared | 0.571342 | -0.025370 |
| Sum sq. resids | 0.001736 | 69.39747 |
| S.E. equation | 0.008884 | 1.776072 |
| F-statistic | 8.197464 | 0.866394 |
| Log likelihood | 95.90373 | -52.43732 |
| Akaike AIC | -6.421695 | 4.174094 |
| Schwarz SC | -6.136223 | 4.459567 |
| Mean dependent | 0.002857 | 0.928652 |
| S.D. dependent | 0.013569 | 1.753962 |
| Determinant resid covariance (dof adj.) | | 0.000249 |
| Determinant resid covariance | | 0.000154 |
| Log likelihood | | 43.46706 |
| Akaike information criterion | | -2.104790 |
| Schwarz criterion | | -1.438688 |
| Number of coefficients | | 14 |

**Vector Error Correction Estimates**

| | | |
|---|---|---|
| **Vector Error Correction Estimates**<br>**Date: 05/15/23 Time: 17:15**<br>**Sample (adjusted): 1993 2020**<br>**Included observations: 28 after adjustments**<br>**Standard errors in ( ) & t-statistics in [ ]** | | |
| **Cointegrating Eq:** | **CointEq1** | |
| **FDI(-1)** | **1.000000** | |
| **IDI(-1)** | **-0.003008**<br>**(0.00020)**<br>**[-15.2569]** | |
| C | **-0.085434** | |
| **Error Correction:** | **D(FDI)** | **D(IDI)** |
| **CointEq1** | **-1.190225**<br>**(0.33798)**<br>**[-3.52158]** | **-69.02608**<br>**(67.5675)**<br>**[-1.02159]** |
| **D(FDI(-1))** | **0.244541**<br>**(0.23388)**<br>**[ 1.04559]** | **60.21562**<br>**(46.7560)**<br>**[ 1.28787]** |
| **D(FDI(-2))** | **-0.161097**<br>**(0.16740)**<br>**[-0.96235]** | **25.32081**<br>**(33.4658)**<br>**[ 0.75662]** |
| **D(IDI(-1))** | **-0.001632**<br>**(0.00151)**<br>**[-1.08355]** | **-0.570117**<br>**(0.30106)**<br>**[-1.89369]** |
| **D(IDI(-2))** | **-0.002168**<br>**(0.00121)**<br>**[-1.79710]** | **-0.241751**<br>**(0.24117)**<br>**[-1.00239]** |
| C | **0.006027**<br>**(0.00245)**<br>**[ 2.46342]** | **1.504164**<br>**(0.48911)**<br>**[ 3.07528]** |
| **R-squared** | **0.650723** | **0.164514** |
| **Adj. R-squared** | **0.571342** | **-0.025370** |
| **Sum sq. resids** | **0.001736** | **69.39747** |
| **S.E. equation** | **0.008884** | **1.776072** |
| **F-statistic** | **8.197464** | **0.866394** |
| **Log likelihood** | **95.90373** | **-52.43732** |
| **Akaike AIC** | **-6.421695** | **4.174094** |
| **Schwarz SC** | **-6.136223** | **4.459567** |
| **Mean dependent** | **0.002857** | **0.928652** |
| **S.D. dependent** | **0.013569** | **1.753962** |
| **Determinant resid covariance (dof adj.)** | | **0.000249** |
| **Determinant resid covariance** | | **0.000154** |
| **Log likelihood** | | **43.46706** |
| **Akaike information criterion** | | **-2.104790** |
| **Schwarz criterion** | | **-1.438688** |
| **Number of coefficients** | | **14** |