Effect of Infrastructure on FDI Behaviour in Kenya: A Growth Nexus Analysis

by

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submitted in accordance with the requirements
for the degree of

DOCTOR OF PHILOSOPHY

in the subject

MANAGEMENT STUDIES

at the

UNIVERSITY OF SOUTH AFRICA

SUPERVISOR: PROF R A AREGBESHOLA

JANUARY 2022

Declaration

I, **Zacharia Kingori**, student number **61139327,** declare that:

Effect of Infrastructure on FDI Behaviour in Kenya: A Growth Nexus Analysis is my own work, and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

Signed:

24 January 2022

Abstract

This study investigates the effect of infrastructure on foreign direct investment (FDI) in Kenya. The study further investigates the effects of FDI on economic growth in Kenya. The study’s objectives lead to the examination of the nexus between FDI, infrastructure and economic growth in Kenya over the period 1970-2019. In the study, both FDI and economic growth are analysed with either infrastructure composite index (INFR), transport infrastructure, energy infrastructure, ICT infrastructure, or water infrastructure. INFR composite index is generated through the principal composite analysis to estimate a system effect of the individual models.

Control variables are included in the models. The control variables consist of some of the key determinants of FDI inflows and which also determine economic growth including market openness, inflation rate, exchange rate, financial development and labour resources.

The study variables are first tested for unit root using Augmented Dickey-Fuller (ADF); Phillips Perron (PP); and Kwiatkowski, Phillips, Schmidt and Shin (KPSS) tests. The unit root results indicate that the variables of the study are a mixture of I (0) and I (1). Hence Autoregressive Distributed Lag (ARDL) Bounds approach is best suited to determine the cointegration of the variables and the long-run relationships. Where cointegration exists, error correction analysis is carried out to determine the long-run dynamics and the short-run causal effects. When there is no cointegration, a short-run analysis is carried out to determine the short-run causal effects. Granger causality test is finally undertaken to test the study's null hypotheses. The diagnostic tests of the time series models are carried out at every appropriate stage.

The ARDL bounds test results reveal that FDI, infrastructure and economic growth are cointegrated. The Granger causality tests confirm that infrastructure Granger causes FDI, FDI Granger causes infrastructure development, infrastructure Granger causes economic growth, and economic growth Granger causes infrastructure development. Therefore, a bi-directional relationship can be said to exist between FDI and infrastructure development, and between economic growth and infrastructure development. The study results find that the hypotheses that economic growth Granger causes FDI, and FDI Granger causes economic growth are not supported by data for Kenya.

The long-run and short-run regression analyses results show that infrastructure (composite index) has a statistically significant positive effect on FDI both in the long and short-run. Transport infrastructure significantly and positively influences FDI in the long-run and economic growth in the short-run. Water infrastructure has a significant positive effect on FDI in the long-run. The ICT infrastructure has a significant negative effect on FDI in the short-run and a significant positive net effect on economic growth. FDI has a significant positive effect on water infrastructure in the short-run. Economic growth has a positive effect on infrastructure (composite index) and water infrastructure in the short-run.

The study results imply that a meaningful inflow of FDI into Kenya is contingent on infrastructure development. Government of Kenya policies should revolve around increasing infrastructure investment, especially in transport and water. Investment in ICT (telephony connections) might not be useful in attracting FDI. A conducive environment should be created to encourage inflows of FDI and growth of the economy, both of which have a causal effect on infrastructure development.

The policies intended to improve FDI inflows, economic growth and infrastructure development may require to be augmented with complementary policy initiatives that would include opening the market, macroeconomic stability, improving human resources and institutional development.

Key Words

FDI; GDP; infrastructure; unit root; ARDL; cointegration; error correction; Granger causality.

Acknowledgement

I would like to express my sincere gratitude to my supervisor, Professor Rafiu Adewale Aregbeshola for the continuous support shown throughout the PhD study. I am particularly thankful for his patience, motivation and immense knowledge. His guidance helped me in all the time of research and writing of this thesis. I could not have imagined having a better supervisor and advisor for my PhD study. His reference to me as “bosom brother” is not only assuring but also calming, encouraging and energising.

I am also grateful to my family, including my wife Purity Njeri, and children (Kings, Lisa and Melisa), for their encouragement, understanding and support while I sat for endless hours while putting together this thesis.

And lastly, I would like to thank my parents (Michael Kingori and Esther Wambui) for their moral and spiritual support.

Acronyms and Abbreviations

ADF	-	Augmented Dickey-Fuller
AIC	-	Akaike Information Criterion
AIDI	-	Africa Infrastructure Development Index
ARDL	-	Autoregressive Distributed Lag
BLUE	-	Best Linear Unbiased Estimate
BoP	-	Balance of Payments
CUSUM	-	Cumulative Sum Control Chart
CUSUMSQ	-	CUSUM of Squares
ECM	-	Error Correction Model
ECT	-	Error Correction Term
ENEI	-	Energy Infrastructure
EViews	-	Econometric Views
FDI	-	Foreign Direct Investment
FY	-	Financial Year
GCF	-	Gross Capital Formation
GDFCF	-	Gross Domestic Fixed Capital Formation
GDP	-	gross domestic product
ICT	-	Information and Communication Technology
ICTI	-	Information and Communication Technology Infrastructure
INFR	-	infrastructure
KPSS	-	Kwiatkowski, Phillips, Schmidt and Shin
Ksh	-	Kenya Shillings
LDCs	-	Least Developed Countries
LM	-	Lagrange Multiplier
LNENEI	-	Log of energy infrastructure
LNFDI	-	Log of foreign direct investment
LNGDP	-	Log of gross domestic product
LNICTI	-	Log of ICT infrastructure
LNINFR	-	Log of infrastructure (composite index)
LNTRAI	-	Log of transport infrastructure
LNWATI	-	Log of water infrastructure
MNCs	-	Multinational Corporations
MTEF	-	Medium Term Expenditure Framework

MW	-	Megawatt
OLI	-	Ownership, Location, Internalisation
OLS	-	Ordinary Least Squares
p	-	Probability
p-value	-	Probability Value
PCA	-	Principal Component Analysis
PP	-	Phillips Perron
PPP	-	Public-Private Partnership
RESET	-	Regression Equation Specification Error Test
SDG	-	Sustainable Development Goal
SGR	-	Standard Gauge Railway
SPSS	-	Statistical Package for the Social Sciences
TRAI	-	Transport Infrastructure
UN	-	United Nations
UNCTAD	-	United Nations Conference on Trade and Development
USD	-	United States Dollar
VAR	-	Vector Autoregression
VECM	-	Vector Error Correction Model
WATI	-	Water Infrastructure

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CHAPTER ONE

INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 Background to the Study

Poor infrastructure is cited as an impediment to economic growth in Kenya and other sub-Saharan Africa countries (Aregbeshola, 2018; Kodongo and Ojah, 2016). Africa faces huge infrastructural gaps. Gutman *et al.* (2015:11) estimate that USD 93 billion is needed in Africa per year to fill the existing infrastructure gap. With such huge infrastructure gaps, any investment in the sector could lead to positive externalities that could augment growth. Kadongo and Ojah (2016) contend that infrastructure directly induces economic growth by being a part of a country's physical stock of capital. Infrastructure indirectly induces economic growth by supplementing other factors of production, facilitating the build-up of factors of production, expanding production frontier by lowering input costs and by stimulating aggregate demand in an economy (Aregbeshola, 2014). Sub-Saharan Africa lacks infrastructure more profoundly than the rest of the world. Hence, investment in Africa's infrastructure could arguably be transformational towards attracting inflow of FDI (Gutman *et al.* (2015). In an earlier study, Agénor and Moreno-Dodson (2006) argue that impacts of infrastructural development on economic growth are more pronounced where stocks of infrastructure assets are relatively low like in developing countries, particularly those in sub-Saharan Africa.

The Economic Recovery Strategy for Wealth and Employment Creation 2003-2007, commonly referred to as ERS (Government of Kenya, 2003), recognises infrastructure as key and critical in achieving economic growth, and ultimately economic development in Kenya. The aim of the strategy was to revitalise the economy towards high and sustainable growth. The expectation was that Kenyan products would be more competitive if the infrastructure was well developed in a way that attracts FDI, leading to long-term economic, social and political development. The trickle-down effects of this development would also apply to the wider East Africa region, given the strategic importance of Kenya in the region.

The successor to the ERS is Kenya's Vision 2030, which is the long-term development blueprint that aims to transform the country into middle-income economic status by 2030 (Government of Kenya, 2007). In the Vision, adequate infrastructure is envisaged as an enabler of economic growth. The Vision aims to make Kenya the top FDI destination in Africa. To that extent, the deployment of excellent infrastructure facilities and services is expected to support the growth of key productive sectors, including agriculture, financial services, manufacturing, business process outsourcing, wholesale and retail, and tourism, through FDI nexus.

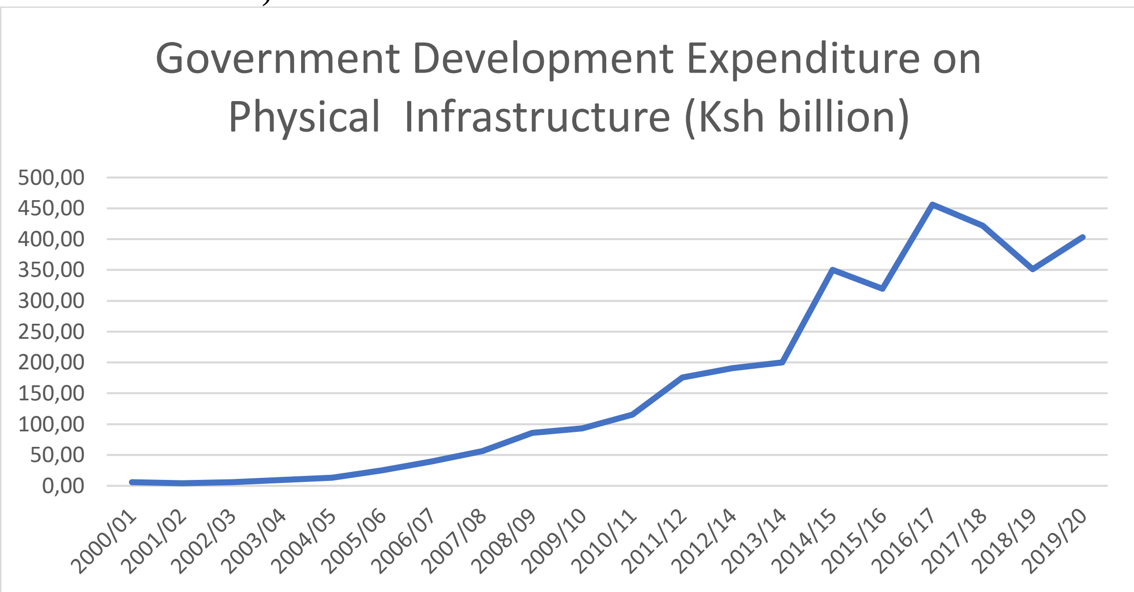
The United Nations' Sustainable Development Goals (SDGs) cite investment in infrastructure as crucial to achieving economic growth and development, especially in the developing economies (UN General Assembly, 2015). Sustainable Development Goal (SDG) no. 6 acknowledges that poor people's food security, choice of livelihood and opportunities in education are negatively impacted by inadequate water, poor water quality and poor sanitation. Therefore, adequate water infrastructure is important to ensure more food is grown, livelihoods are improved, and education conditions are made better.

Furthermore, Goal no. 7 of the SDGs stipulates that lives and economies are transformed through the provision of sustainable energy. In that, the provision of sustainable energy is considered vital to improve the living conditions of people and attain economic growth. The importance of developing infrastructure that improves working conditions and helps in attaining sustainable economic growth is emphasised through SDG no. 8. The SDG Goal no. 8 promotes the provision of decent work for all, full and productive employment, and sustainable economic growth that is also sustainable and inclusive.

In addition, Goal no. 9 identifies infrastructure investment, including investment in information and communication technology (ICT), transport, energy, and irrigation, as paramount in the realisation of sustainable development and the empowerment of communities. In summary, the SDGs goals 6, 7, 8 and 9 consequently proposes the improvement in infrastructure as an avenue to improve the living conditions of people and for economies to attain sustainable growth.

However, it is essential to note that Kenya has invested heavily in infrastructure development, especially in the last two decades. Figure 1-1 shows the trend in investment by the Government of Kenya on physical infrastructure between 2000 and 2020. The Figure suggests that investment in infrastructure has increased significantly in the last two decades. The change of government and policies around 2002 precipitated the increase in expenditure on infrastructure, and the trend has been sustained ever since then. Substantial amounts of funds, including foreign loans, have been used to expand transport infrastructure (roads and rail), energy grids and connections, ICT and water supply.

Figure 1-1: Government Development Expenditure on Physical Infrastructure (2000/01-2019/20)



Sources: created by Author from data sourced from Government of Kenya Statistical Abstracts, various issues (1990-2020).

To be more specific, Table 1-1 is presented to shed light on the specific areas where the investment in infrastructure has been directed. Specifically, the table documents the summary of government investment in the provision of physical infrastructure between 2000 and 2019:

Table 1-1: Infrastructure Budget 2000-2019, in Ksh (Million)

	Transport	ICT	Energy	Water	Total
2000/01	2,624.30	-	1,279.70	1,983.41	5,887.41
2001/02	1,480.60	11.70	1,343.10	1,343.13	4,178.53
2002/03	2,255.60	8.20	1,494.50	2,319.13	6,077.43
2003/04	2,833.60	19.00	2,689.20	4,169.29	9,711.09
2004/05	4,252.09	-	5,751.04	3,210.21	13,213.34
2005/06	10,229.55	76.54	8,397.56	6,598.70	25,302.35
2006/07	23,579.00	418.60	8,208.00	7,592.10	39,797.70
2007/08	27,921.00	2,275.60	17,704.00	8,414.30	56,314.90
2008/09	38,292.00	1,462.00	30,560.00	15,290.60	85,604.60
2009/10	40,125.00	1,344.00	32,872.00	18,648.60	92,989.60
2010/11	51,267.00	3,687.00	29,590.00	31,095.20	115,639.20
2011/12	92,382.00	3,560.00	53,334.00	26,511.20	175,787.20
2012/14	91,602.00	6,481.00	64,640.00	27,833.10	190,556.10
2013/14	107,182.00	5,824.00	54,266.00	32,888.40	200,160.40
2014/15	255,569.00	6,622.00	55,168.00	32,647.50	350,006.50
2015/16	189,084.00	14,371.00	74,774.50	41,279.00	319,508.50
2016/17	302,246.00	31,239.00	78,706.00	43,850.70	456,041.70
2017/18	304,996.00	11,053.00	69,141.00	36,509.20	421,699.20
2018/19	244,909.00	21,106.00	53,910.00	31,131.00	351,056.00
2019/20	289,888.00	15,006.00	52,408.00	45,831.50	403,133.50

Source: Republic of Kenya "Energy, Infrastructure and Information, Communications Technology (EII) Sector MTEF Budget Reports", various issues; and "Environmental Protection, Water and Natural Resources Sector Reports MTEF Budget", various issues.

According to Table 1-1, the overall government expenditure on infrastructure development increased from Ksh 5,887.41 million (USD 77.29 million) in 2000 to a high of Ksh 456,041.70 million (USD 4492.84 million) in 2016, before slowing down to Ksh 403,133.50 million (USD 3952.63 million) in 2019 (Republic of Kenya, 2018 and 2020). The change in infrastructure budget from 2004 to 2019 is an overall increase of 224 per cent, attributed to funding by the government to priority projects that include the completion of Standard Gauge Railway (SGR) construction from Mombasa to Naivasha. The construction of Kenya's biggest infrastructure project, the 969 kilometre Mombasa-Malaba SGR is worth USD11.9 billion, and commenced in 2013. The budget included the construction of Mombasa – Nairobi (472km) in which Phase 1 was completed in May 2017. Furthermore, the construction of Nairobi – Naivasha (120km)

Phase 2 was completed in October 2019. Funding for Phase 3 that connects Naivasha, Kisumu and Malaba (377km) is being mobilised, and the railroad is intended to ultimately connect to Kampala in Uganda.

Given the strategic importance of road network infrastructural development to the Government of Kenya, it is important to note that the budgetary allocation for railway development in the 2017/2018 financial year (USD 25 billion) was approximately half of Kenya's total budget for the year. Other big infrastructure projects are under implementation in the transport, energy, ICT, and water and sanitation sectors. Major road projects currently being implemented include the Nairobi Expressway and Kenol – Sagana - Maruia Highway. The Nairobi Expressway construction started in June 2020 and is costing Ksh 62 billion (USD 580 million). The dualling of 84 kilometres of Kenol - Sagana - Marua Highway (part of Trans African Highway no. 4) started in July 2020, costing Ksh 16.7 billion (USD 156 million).

Total funding of the road sub-sector rose from USD 0.5 billion in 2008 to USD 2.0 billion in 2017 (Government of Kenya - Economic Survey, various issues 2009-2020). Evidently, substantial amounts of Kenya's financial resources are being channelled to infrastructure development. This heavy investment in infrastructural development is expected to drive an increase in the inflow of FDI over the same period. However, the period has experienced a relatively lower inflow of FDI as compared to the period before the heavy investment in infrastructural projects. Unfortunately, the increased expenditure on infrastructure development has led to a huge debt burden for the country and the expected level of FDI has not been realised.

Table 1-2 documents this reality:

Table 1-2: GDP, Debt and FDI in Kenya

	GDP (Ksh billion)	Real GDP Growth Rates	Government Debt (Ksh billion)			Debt as a % of GDP	FDI net inflows (BoP, current Ksh billion)	FDI net inflows (% of GDP)
			Domestic Debt	External Debt	Total Debt			
2000	967.84	0.6	206	396	602	62.20	8.45	0.87
2001	1,020.22	4.4	212	394	606	59.40	0.42	0.04
2002	1,035.37	0.4	236	378	614	59.30	2.17	0.21
2003	1,131.78	2.9	289	407	696	61.50	6.21	0.55
2004	1,274.33	5.1	306	443	749	58.78	3.65	0.29
2005	1,415.73	5.9	316	434	750	52.98	1.60	0.11
2006	1,862.04	6.3	358	431	789	42.37	3.65	0.20
2007	2,151.32	7.0	405	397	802	37.28	49.08	2.28
2008	2,483.08	1.6	431	440	871	35.08	6.61	0.27
2009	2,863.64	2.7	518	535	1053	36.77	8.99	0.31
2010	3,169.34	5.8	660	565	1225	38.65	14.11	0.45
2011	3,725.95	4.4	764	723	1487	39.91	128.82	3.46
2012	4,261.39	4.5	859	775	1634	38.34	116.67	2.74
2013	4,745.11	5.9	1,051	844	1,894	39.91	96.36	2.03
2014	5,402.67	5.4	1,284	1,086	2,370	43.90	72.18	1.34
2015	6,284.23	5.7	1,420	1,409	2829	45.00	60.84	0.97
2016	7,022.95	5.9	1,815	1,803	3,618	51.50	68.90	0.98
2017	8,165.81	4.8	2,220	2,349	4,569	56.00	130.93	1.60
2018	8,892.11	6.3	2,548	2,724	5,272	59.30	164.71	1.85
2019	9,740.48	5.4	2,942	3,107	6,049	62.10	135.90	1.40

Sources: Government of Kenya Economic Surveys; World Bank World Development Indicators; Central Bank of Kenya Annual Reports and Financial Statements.

As evident from Table 1-2, FDI net flows was quoted at time best in Kenya in 2011. Specifically, net inflow of FDI as a percentage of GDP has decreased from 3.46 per cent in 2011 to 1.40 per cent in 2019. The relative FDI levels are low compared to past achievements, therefore creating a possibility for the potential increase in FDI inflow to the country.

To positively enhance the inflow of FDI, the Kenyan Government has taken and implemented reformative measures to improve the country's attractiveness to FDI inflow. Some of the initiatives have borne positive results, especially because Kenya has made headway in the World Bank's Doing Business ranking (The World Bank, 2020). Kenya ranking for the ease of doing business was 56th worldwide in 2019, an improvement from 2013 when it was ranked 129th. Furthermore, the government has strived to improve the functionality of the governance architecture, improve infrastructure, encouraged business process outsourcing, and has passed a law to support public-private partnership (PPP). Under the Kenya Vision 2030, the government aim to make Kenya a top offshoring destination in Africa through Business Process Offshoring (BPO) (Government of Kenya, 2007). Moreover, the country looked forward to raising the level of investments from 20 per cent to over 30 per cent of GDP. Of this, private sector investments rose from 15.6 per cent of GDP in 2007 to 22.9 per cent in 2013 and over 24 per cent of GDP from 2021 to 2030. It is expected that the investment climate improvement and sustained good economic performance would improve the stock of FDI, which is a significant component of private investment.

The PPP law was adopted in 2013 to attract FDI in infrastructure development. Furthermore, the Company Act of 2015 modernised procedures of registration and operations of companies, while the Business Registration Services (BRS) Act passed in the same year sought to cut expenses directed towards company registration, while the insolvency Act of 2015 improved the legal framework in bankruptcy. In addition, the government in 2017 undertook the Kenya Investment Policy, which revised the registration affecting the entire investment network. This was done to strengthen the investment environment that strategically underpins the growth envisaged by the government. Kenya has also signed 14 bilateral investment conventions over the past decade.

One of the widely cited obstacles to investment in the economy is the inadequate and poor-quality infrastructure. According to statistics provided in the AfDB Africa Infrastructure

Development Index (AIDI[1]) 2020, Kenya's infrastructure development level is low. Kenya had an index of 26.09 in 2020, which is uncompetitive. The index can be interpreted as a measure of infrastructure access (an index nearer to 100 means more access), implying that Kenya' current infrastructure is inadequate. The AfDB indicates that infrastructure is vital for economic growth and contributes to the SDGs (AfDB, 2020). Through the long-term development plan (Kenya Vision 2030), the government contemplates to restore and expand the infrastructure stock to make a significant contribution to achieving the intended level of private investment (Government of Kenya, 2007). The plan seeks to deploy resources to access infrastructure services and to develop the needed capacity. Infrastructure services targeted to be accessed include transport, energy, telecommunications, and water and sanitation. The government says it seeks to have the country interconnected with adequate roads, ports, railways, airports, and waterways; more telecommunications access; energy generation and consumption; and improved water and sanitation services. Investment in infrastructure is being given the highest priority.

Several studies have shown a strong correlation existing between infrastructure development and the inflow of FDI. Infrastructure is cited as constituting the wheels of development in some developing economies (Aregbeshola, 2014; Prakash, 2005). Bakar *et al*. (2012) contend that infrastructure (highways, bridges, ports, communications) that are good are likely to attract additional FDI. Other studies such as Khadaroo and Seetenah (2010) and Coughlin *et al.* (1991) suggest that infrastructure development provides a significant role in determining FDI inflows to a country, while Wheeler and Mody (1992) argue that quality infrastructure is vital to attracting FDI in developing countries and less critical to developed countries that already have

[1] The annual production of AIDI by AfDB helps countries to benchmark their infrastructure sectors comparative performance. The benchmarking assists the countries to formulate strategies that are specific to their countries borrowing from regional experience.

high-quality infrastructures.

In sustainable cases, infrastructure is mainly financed through PPP initiatives. However, the case of Kenya is different. In the Kenyan situation, most of the typically large public infrastructure projects are financed with debts from bilateral and multilateral lenders (Kamau, 2016). The debt levels have risen from Ksh 0.6 trillion in 2002 to Ksh 6.0 trillion in 2019. As a result of this huge debt burden, the government's debt to GDP ratio ballooned to 62.10 per cent in 2019 from a low of 35.08 per cent in 2008 (see Table 1-2 above). But the government is hopeful that the debt burden mostly attributed to heavy infrastructure investment will enhance productive capacity and fuel economic growth (Government of Kenya, 2007). However, over-indebtedness can cause a vicious circle where the inability to finance new investment projects can curtail the generation of economic growth and debt servicing (Lora, 2007).

The gross domestic product (GDP) of Kenya between 2004 and 2019 has averaged a 5.2 per cent growth rate per annum (Government of Kenya - Economic Survey, various issues 2004-2018). Under Kenya Vision 2030, the government aimed to increase the economy's growth rate from 6.1 per cent in 2006 to 10 per cent by 2013 and sustain that growth into the future. Among the sectors that were targeted to help attain and sustain this growth rate were FDI and infrastructure development (Government of Kenya, 2007). Investment in infrastructure leads to increased economic growth and higher per capita income, consequently reducing poverty by enhancing living standards (Aregbeshola, 2018; Siyal *et al.*, 2016). The growth in GDP is attributable to several factors, including the improvement of infrastructure (Ansari *et al*., 2010).

The association of infrastructure development to the attraction of FDI inflows has positive externalities to economic growth. While infrastructure is claimed to positively affect economic growth, it is also argued that FDI affects economic growth directly and indirectly (Aregbeshola, 2014; Almfraji and Almsafir, 2014). FDI stimulates domestic investment, helps create employment opportunities, aids the transfer of new technology and promotes economic development. Whereas FDI stimulates economic growth, growth in FDI is in most cases associated with good infrastructure. In this study, the effects of FDI on economic growth (proxied by GDP) is interrogated.

Despite the advantages thought to exist, caution must be excercised on the relationship between infrastructure, FDI and economic growth. This link has remained somehow blurred, specifically for Kenya. This is the main objective why this study is considered very important. To that extent, unravelling this relationship is important in the face of relatively large government expenditures in physical infrastructure and the expected impacts on the inflow of FDI that is expected to drive economic growth. The spending, especially from debts, can only be justified if the developed infrastructure helps attract FDI to foster sustainable economic growth. This study seeks to determine a long-run relationship between infrastructure, foreign direct investment and economic growth; and the directions of causation involved. In a more specific term, the study was set out to investigate the statistical relationships between infrastructure, economic growth and FDI in Kenya.

1.2 Problem Statement

FDI inflows to Kenya remain relatively low considering the size of its economy and its development level when compared to other developing countries, particularly other countries in sub-Saharan Africa. According to World Investment Report 2020 (United Nations, 2020:34), the inflow of FDI to Kenya shrank by 18 per cent to USD 1.3 billion in 2019 (in comparison to USD 1.6 billion in 2018). In addition, the FDI flows to sub-Saharan Africa decreased by 10 per cent in the same period (United Nations, 2020:34). The United Nations acknowledges that while Kenya dominated in the attraction of FDI in the East Africa region in the 1960s and 1970s, the country has underachieved considerably in the last couple of decades.

These new findings by the global body had been observed in an earlier study by Nyamwange (2009), who opined that the level of FDI in Kenya has been declining and stagnant for years and below its potential, with foreign investors relocating from the country to more favourable countries. The FDI inflows as a percentage of GDP decreased from 3.46 per cent in 2011 to 1.40 per cent in 2019 (see Table *1-2*). The decline goes against the initial plan contained in the Kenya Vision 2030, where the government aimed to raise the private sector investments from 15.6 per cent of GDP in 2007 to 22.9 per cent in 2013, and over 24 per cent from 2021 to 2030. FDI was supposed to comprise a significant share of the increase in private investments.

The decreasing FDI behaviour (changes in the levels of FDI) is of interest in the face of heavy investment by the government in infrastructure development and the importance of FDI as the identified most important catalyst of economic growth in Kenya (see Nyamwange, 2009). The heavy investments in infrastructure and the concomitant fiscal policy redefinition are justifiable if it can be ascertained that the investment impacts FDI inflows positively and helps the economy grow. Conversely, an argument may be advanced for a reverse causal effect, provided the heavy investment in infrastructure was because of the externalities generated by existing FDI assets in the county. Therefore, it is worthwhile to determine whether the investment in infrastructure is owing to the underlying FDI and economic growth.

Chingoiro and Mbulawa (2016) contend that there is no clarity on the relationship between economic growth and infrastructural development in Kenya. In a previous study, Pradhan and Bagchi (2013) argue that investigations of causality hypotheses are readily available in the literature with controversial and inconsistent outcomes. Studies show the differing direction of causality between infrastructure and other variables of interest, such as economic growth and FDI. Causality could be unidirectional or bidirectional, or no causality. Some of the leading studies in this regard have disagreed on the direction of causality between infrastructure development, FDI and economic growth (see Siyal *et al.*, 2016; Owolabi, 2015; Kaur and Malhotra, 2014; Pradhan *et al.*, 2013; Pradhan and Bagchi, 2013; Banerjee *et al.*, 2012).

This study seeks to determine the effect of infrastructure development on FDI inflows and its relation to economic growth in Kenya. Furthermore, the research seeks to ascertain the causality between infrastructure, FDI inflows and economic growth, focusing on the Kenyan economy. The literature review reveals an existing gap (inconsistent causal relationships) in studying the effects of investment in infrastructure on FDI and economic growth in most developing economies. Studies that have explored the nexus between infrastructure, FDI and economic growth are rare. In specific terms, this study attempts to unravel the underlying causal relationship between infrastructure (and its sub-sectors), economic growth and FDI inflows in Kenya in the face of the below-par performance in the FDI sector and the economy, and the skyrocketing debt burden arising from increasing infrastructure investments. Potential heterogeneity in the relationship between these variables calls for single-country research and calls for examining new evidence for Kenya using a robust scientific methodology.

1.3 Research Objectives

The main research objective is to empirically explore the effect of infrastructure on the attractiveness of Kenya to the inflow of FDI. The study further investigates the effects of FDI inflows on economic growth in Kenya. As suggested in the literature review presented in section 1.2, infrastructure development helps attract FDI. Furthermore, it is documented in the literature that the inflow of FDI enhances economic growth. In addition, a possible bidirectional causal relationship is also established in previous studies (Chingoiro and Mbulawa, 2016; Pradhan *et al.,* 2013; Pradhan and Bagchi, 2013). This may indicate a possible cyclical effect in which investment in infrastructure enhances the inflow of FDI that drives growth, which conversely leads to further investment in infrastructure. This study considers it important to ascertain the direction of causality among these variables of interest to determine the specific causal relationship between them as a policy pointer to the government.

The sub-objectives of the study are identified below:

- To reveal the effect of infrastructure development on FDI in Kenya
- To investigate the effect of infrastructure development on economic growth in Kenya
- To examine the effect of FDI on infrastructure development in Kenya
- To determine the effect of FDI on economic growth in Kenya
- To reveal the effect of economic growth on FDI in Kenya
- To investigate the effect of economic growth on infrastructure development in Kenya.

1.4 Research Questions

The main research question is 'What is the effect of infrastructure development on the inflow of FDI to Kenya? Another pertinent question is to investigate what specific effect the inflow of FDI has on economic growth in Kenya? These research questions are cascaded into very specific research questions as follows:

- What is the effect of infrastructure development on FDI in Kenya?
- What is the effect of infrastructure development on economic growth in Kenya?
- What is the effect of FDI on infrastructure development in Kenya?
- What is the effect of FDI on economic growth in Kenya?
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- What is the effect of economic growth on infrastructure development in Kenya?

1.5 Hypotheses of the Study

The study tests the following six hypotheses:

H1: Infrastructure Granger causes FDI

H2: Infrastructure Granger causes economic growth (GDP)

H3: FDI Granger causes infrastructure development

H4: FDI Granger causes economic growth (GDP)

H5: Economic growth Granger causes FDI

H6: Economic growth Granger causes infrastructure development

1.6 Significance of the Study

The study mainly informs on the influence of infrastructure on the attractiveness of Kenya to the inflow of FDI. Furthermore, the study investigated the role of FDI in galvanising economic growth. The research also reports the effect of FDI and economic growth on infrastructure development and vice versa. The research further reports on the relationship of individual infrastructure sub-sectors (energy, transport, water and ICT) with FDI and economic growth. The literature review revealed that infrastructure development helps attract FDI and supports economic growth. The literature further informs that FDI and higher economic growth support infrastructure development. Studies in other countries have found various conflicting cause-effect relationships between the three variables (Chingoiro and Mbulawa, 2016; Pradhan *et al.*, 2013; Pradhan and Bagchi, 2013; Nyaosi, 2011).

This specific study is considered helpful for policymakers as it informs guidance on future policies on infrastructure development in Kenya, especially the heavy infrastructure investments that are laddered with huge debt financing. From the results generated in this study, policy recommendation is made on whether it is financially expedient to continue investing in infrastructure to attract more FDI as an enhancer of sustainable economic growth in Kenya. When budget constraints are incredibly tight (as currently being experienced in the country), it is worth prioritising public spending with the highest multiplier effects on growth at the expense of white elephant projects that may ultimately weaken the country's macroeconomic stability (Broyer and Gareis, 2013).

This study analyses the causal relationship between infrastructure (transport, energy, ICT and water), FDI and economic growth in Kenya. The study results inform whether the continued heavy investment in infrastructure is good for attracting FDI and growing the Kenyan economy. The results also reveal whether FDI leads to infrastructure development and economic growth and unveils the impact of economic growth on infrastructure investment and FDI.

This research on Kenya is educative to policymakers and researchers in neighbouring countries whose economies face similar needs and challenges of attracting FDI and fostering economic growth. As Ghura *et al.* (2000) observe, the lessons learned from many SSA (SSA) countries successful experiences offer some helpful policy guidance for further progress in the region. SSA countries face significant challenges in improving growth, decreasing poverty and integrating their countries into the world economy. The subject of this research and the potential applicability to other SSA countries that share similar characteristics with Kenya categorises this study as a topic in International Business, primarily because of the competitive nature of FDI movement across borders, especially within the sub-region, and the specific role that infrastructure plays in the conduct of International Business. According to the review of literature presented in section 1.2, multinational corporations (MNCs) need infrastructure like functional and accessible communication services to coordinate cross-border activity. The literature further suggests that interconnectivity of transportation network, ICT and energy facilitate trade and regional integration – all these are important components of International Business.

1.7 Definition of Key Terms

1.7.1 Foreign Direct Investment

The study uses annual time series data of Real FDI net inflows (BoP) as a proxy representing foreign direct investment. FDI inflows are defined as the net inflows of investment to obtain a long-term management interest (voting stock of 10 per cent or more) in a firm operating in a foreign economy (The World Bank, 2021). FDI net inflows are divided by the consumer price indices to get the real FDI net inflows.

1.7.2 Economic Growth

The real gross domestic product (GDP) annual growth rate is utilised to represent economic growth. GDP is the measure of the monetary worth of goods and services that are produced inside the country by both citizens and non-citizens. It is commonly defined as growth in output or production (goods and services) in an economy. The real GDP measurement factors out inflation occurring during the period of calculation.

1.7.3 Infrastructure

This study utilised physical infrastructure to represent infrastructure. Physical infrastructure is measured in physical terms, such as main telephone lines, length of the road network, Port TEU (twenty-foot equivalent unit) cargo capacity, electricity generation capacity, the number of persons with access to safe, clean drinking water, etc.

In the study, infrastructure is used differently in two ways. Firstly, at the particular sector level, transport infrastructure (TRAI), energy infrastructure (ENEI), ICT infrastructure (ICTI) and water infrastructure (WATI) are treated individually; secondly, at the group level, using a composite index, where all infrastructure is linked contemporaneously. The proxies used are length (kilometres) of paved roads (transport), telephony connections (ICT), electricity installed capacity (energy), and government water supply expenditure (water).

1.8 Contributions to Knowledge

The study augments existing knowledge about FDI, economic growth and infrastructure development in Kenya. Moreover, the study utilised the composite infrastructure index (created through the principal component analysis (PCA) method, and individual infrastructure variables (transport, energy, water and ICT) to examine their causal relationship with both FDI and economic growth. The use of the composite index is also rare, while system equation estimation of individual explanatory variables as deployed in this study is uncommon in degree-orientated studies.

The study also utilises a combination of the ARDL bounds approach, Vector Error Correction Model (VECM) and Granger causality test to investigate the relationships between infrastructure and FDI, as well as between FDI and economic growth. The study also investigates reverse causality between economic growth and infrastructure development. Previous studies that investigated the main relationships focused on this study are rare, and the need to investigate these relationships in the specific case of Kenya has not received attention in academic studies. More importantly, the deployment of PCA to estimate the joint importance of infrastructure, followed by a system estimation that introduces each of the components of infrastructure, adds uncommon academic value.

The ARDL bounds test allows the researcher to estimate the long-run and short-run parameters of the models simultaneously and leads to the determination of causality between variables of the study. The ARDL procedure is considered more advanced than the rest of the cointegration techniques as is appropriate for analysing non-stationary and a mixture of time series data that has an integration of order zero 1(0) and order one 1(1). ARDL method is also ideal for the estimation of cointegration in the case of available small sample size as in this study.

1.9 Scope and Delimitation of the Study

This study uses secondary time series data for the period 1970 to 2019. A change of Government in Kenya in 2002 led to a change in policies and increased investment in new infrastructure and rehabilitation of existing and dilapidated facilities. Hitherto, investment in infrastructure had been comparably low, and the immediately preceding period had also been characterised by low growth. It is noteworthy that impressive positive growth rates have been realised after 2002, coming from a negative growth (-0.2 per cent) recorded in 2000 (Economic Survey, 2003). The study looks at the effects of the investment in infrastructure (transport, energy, ICT and water) to ascertain if this heavy investment has catalysed the attractiveness of Kenya to the inflow of FDI. The inflow of FDI is considered a primary enhancer of economic growth by the government, which justifies the exceptionally huge investment in infrastructure development.

The study assumes that all government budget allocations on infrastructure are used for the intended investment. Some funds may have been lost through corruption and institutional inefficiencies, hence not wholly translated into infrastructure investment. Government expenditures on infrastructure might have crowded out private investments and thereby discourage inflow of FDI, and ultimately, affected economic growth negatively. However, the use of physical infrastructure to represent infrastructure is thought to eliminate this deficiency. Studying the impact of infrastructure through the physical-based measure (roads, railways, power, telephone, etc.) leads to more reliable results that better represents actual infrastructure endowment of the economy, irrespective of corruption-efficiency considerations (Calderon and Serven, 2014).

1.10 Chapter Overview

This study is structured as follows: Chapter 1 contains the introduction and background information relating to the study. The chapter lays out the roadmap for the study by signifying the major focus of the study, the research questions, research objectives and the research hypotheses. The chapter also lays a basis for the review of literature by looking at a few major studies that document the kind of relationship being envisaged in the study, albeit in a synoptic manner.

Chapters 2 and 3 examine both theoretical and empirical evidence on infrastructure investment, FDI and economic growth. The chapters review available literature on various critical variables of interest in the study, such as economic growth, FDI inflow, and infrastructural facility. The chapters further lay a theoretical foundation for the study to justify the methodology deployed in the study.

Chapter 4 consists of a description of the data and the empirical methodology employed in the study. This chapter discusses variables of interest, and the econometric models are also presented and explained. In addition, the most suitable approach for the kind of data generated for the study is equally discussed. The presentation of empirical findings is documented in Chapter 5, and efforts are made to relate the findings to the body of existing literature. In chapter 6, conclusions and policy directions are provided centered on the findings of the study. The study concludes by suggesting possible areas of future research.

CHAPTER TWO

INFRASTRUCTURE DEVELOPMENT AND INFLOW OF FOREIGN DIRECT INVESTMENT

2.1 Introduction

This chapter provides an overview of available literature on the relationship between infrastructure development and the inflow of FDI. The chapter builds on the contents of chapter one (introduction), which gave the background to the study where the existing situation in Kenya concerning infrastructure development as a possible driver of FDI is presented. As indicated in chapter 1, the main research objective was to empirically explore the effect of infrastructure on the attractiveness of Kenya to the inflow of FDI. The research aimed to examine, among others, the relationship between infrastructure development and FDI in Kenya. This chapter mainly discusses theoretical, conceptual, and empirical literature on FDI and infrastructure. A literature synthesis is given at the end of the chapter. The review lays an important contextual basis for the theoretical underpinning of this study.

2.2 Understanding Foreign Direct Investment and Infrastructure

2.2.1 Foreign Direct Investment

FDI is defined in various forms. FDI, also referred to in this study as FDI inflow, happens when an investor secures foreign business assets or opens business operations in a foreign country. FDI is a set of several components which enables a firm to work and supply goods and services in a foreign market (Farrell, 2008). These components include capital, technology, entrepreneurship, and management.

FDI is both physical and immaterial capital moved across borders causing economic growth in the receiving economy (Ketteni and Kottaridi, 2019). FDI by way of capital accumulation, the addition of new inputs in the production function and inclusion of foreign technologies in the country of destination, directly impacts economic growth (Almfraji and Almsafir, 2014). FDI can either be horizontal or vertical. Horizontal FDI occurs when the foreign investor engages in similar production activity in the foreign country as in the home country. Conversely, vertical FDI occurs when production processes are fragmented, and different processes are undertaken in different locations (countries) where production cost is minimised.

Direct investment is distinguishable from portfolio investment as the investor directly controls the affairs of the firm in the foreign country, which is not the case under portfolio investment. FDI means international production and is influenced by the cost of doing business abroad or risks and uncertainties (Hymer, 1976). With global production, cross-border investments and trade are involved. To internalise structural imperfections in foreign markets, multinational enterprises (MNEs) must invest across borders to reap ownership advantage that emanates from home-market dominance.

FDI is one of the primary sources of external funding in developing countries (Agbola, 2014). It is also noteworthy that inward FDI can play a vital role in the foreign country by increasing and supplementing funds for domestic investment and when foreign investors buy local inputs. The trend continues when local manufacturers sell intermediate inputs to foreign investors through the production chain (Belloumi, 2014). Many developing countries, including countries in SSA, compete to attract FDI and realise economic growth through tax incentives and subsidies. Then FDI funds can be available for developing infrastructure, which can pay back, enabling the investors to make profits.

One of the critical motivations for FDI inflow is that this form of investment helps a country earn foreign exchange by increasing earnings from exports. Furthermore, FDI can help create new employment opportunities, technology transfer and boost the host country's economic growth. However, a converse implication of FDI is that it could very easily crowd out uncompetitive local investment (Waikar *et al*., 2011). Furthermore, foreign investment is risky in that profits are extracted, or the economy is retooled for foreign nationals at the expense of the domestic workforce (Carbonell and Werner, 2018). Empirical evidence has shown an increase in inequality in developing countries arising from FDI. An increase in FDI in a country will probably raise or lower the relative demand for high-skilled labour, consequently raising or reducing income inequality (Figini and Görg, 2011). The high levels of employment and wages of high-skilled labour in relation to low-skilled workers will result from the expansion of high-skilled labour demand. The result is inequality in income between skilled and low-skilled labour segments of the country. Nevertheless, the converse would happen when FDI demands more low-skilled labour in relation to skilled workers.

2.2.2 Infrastructure

A standard definition of the term 'infrastructure' does not exist, sometimes classified variously with different techniques of measurement, with many studies using the term in relation to its economic impact (Torrisi, 2009). Infra is a prefix meaning "below". Infrastructure is defined as a country’s and its economy’s "underlying structure", the fixed installations that it requires to function (Merriam-Webster, 2021). The infrastructure includes roads, airports, railways and subways, harbours, bridges, water and sewer systems, and dams. These infrastructures are mostly government-built and largely publicly owned.

The public mostly uses infrastructure goods, resulting in economists labelling them as physical infrastructure (Snieska and Simkunaite, 2009). In addition, Agénor and Moreno-Dodson (2006) indicate that studies on infrastructure and growth broadly define infrastructure to include energy, ICT, transport, and water supply and sanitation. Rostow (1960) calls infrastructure 'social overhead capital', which includes railways, ports, roads, and so on.

Four different kinds of infrastructure measurement are used, including financial stock, financial flow, physical-based measure, and common inventory method (CIM), and each leads to dissimilar values and concomitant results (Torrisi 2009). The financial stock and financial flow are monetary infrastructure measurements where infrastructure could be calculated as a flow or a stock variable. According to Irmen and Kuehnel (2008), the financial stock measure corresponds to government spending on public services that instantaneously affect production. In the financial flow instance, present government expenditure is added to public capital stock and affects the future production process.

The physical-based measure of infrastructure looks at the physical endowment considered solely in physical terms such as length of roads, railways, telephone connections, internet connectivity, electrical generating capacity, and water supply connections (Torrisi, 2009). The CIM method involves measuring the physical endowment and then transforming it in monetary terms, attributing a price to each category of good. Therefore, CIM is another monetary measure of infrastructure. Torrisi (2009) argues that the monetary approach measurement would be preferable for national accountability purposes as the whole framework is characterised by monetary values. Studying the impact of infrastructure through the physical-based measure (roads, railways, power, telephone, etc.) leads to more reliable results that better represent real infrastructure endowment of the economy, irrespective of corruption-efficiency considerations (Calderon and Serven, 2014). Calderon and Serven (2014) argue that studies using monetary measures of infrastructure are less conclusive compared to those using physical measures of infrastructure. The physical-based measure of infrastructure, which leads to more reliable results that better represent real infrastructure endowment of the economy, is used in this study. Aschauer (1989) argues that 'core' infrastructure composed of water systems, highways and streets, mass transit, airports, electrical and gas facilities, and sewers possess more significant explanatory power for productivity.

2.3 Theoretical Literature Review

2.3.1 The Determinants of Foreign Direct Investment

Several conventional and contemporary theories attempt to explain the behaviour of FDI. The conventional theories explain why international trade occurs. The contemporary theories explaining FDI behaviour include capital market theory, location-based approach to FDI theories, institutional FDI fitness theory, dynamic macroeconomic FDI theory, and eclectic paradigm theory.

2.3.1.1 Conventional Theories of International Trade

Different regions of the world have been enriching themselves by exchanging goods and services since time immemorial. The inter-regional differences in endowments of primary factors supplies, technology and climate conditions, and demand patterns have driven investments and trade. The supply-side endowment led Adam Smith (1776) and David Ricardo (1817) to make their theories on trade flows and accruing benefits (Ozawa, 1992). Smith derived the absolute advantage principle where the economies of scale are realised from an extended market through exports. Ricardo generated the comparative advantage doctrine based on allocative efficiency arising from specialisation. Moreover, the Heckscher-Ohlin theory extended Ricardo's comparative advantage theory and stated that capital-rich countries with scarce labour resources would export capital-intensive products and vice versa (Ozawa, 1992). These three traditional theories assume the international immobility of factors of production and are mostly geared only at explaining international trade. Therefore, the theories explain international trade as happening owing to inter-economy divergences in supply and demand conditions caused by differences in productivity and factor endowments. The country-specific features cause pre-trade commodity prices discrepancies between countries. The theories face criticism because they assume the non-existence of firm-specific advantages and only perfect competition exists.

The traditional theories attempted to explain trade among nations and related accumulation of wealth, and hence economic growth. The need to exploit economies of scale, foreign resources and opportunities derive the firms not to solely export goods but to produce goods in foreign lands where more profits and efficiency are realisable. As propounded by traditional theories, the opportunity for trade among nations leads firms to decide on the best environment (local or foreign) to produce goods for trade.

2.3.1.2 Capital Market Theory

The capital market theory is also identified as the currency area theory and is attributed to the work of Aliber (1970). The theory postulates that FDI arises mainly because of capital market imperfections. It is indicated that FDI arises owing to variations in home and foreign country currencies (Nayak and Choudhury, 2014). Aliber (1970) argues that currencies that are weak have greater capability to attract FDI and are placed better to take advantage of market capitalisation rate differences compared to stronger currencies. Country of origin MNCs based in hard currency areas can borrow funds at interest rate that is minimal compared to host country firms as portfolio investors overlook the country of origin MNCs foreign aspect (Aliber, 1970). The country of origin businesses can get cheaper funding for their overseas affiliates and subsidiaries and hence get the borrowing advantage than the local firms for similar funds. The capital market theory may hold for developed countries but has been facing criticism for ignoring fundamentals of basic currency risk management (Makoni, 2015). Lall (1979) criticised the theory by arguing that it is inapplicable in the least developed countries (LDCs), where capital markets are highly imperfect or missing, and foreign exchange rates are heavily regulated. Giving the example of Chinese enterprises with sizeable investments in the United States of America (USA) and the United Kingdom (UK), Nayak and Choudhury (2014) argue that the capital market theory fail to explain how MNCs in developing countries having weaker currencies can invest in developed countries purported to have stronger currencies. The capital market theory would imply that exports should come from countries endowed with capital and those countries with inadequate capital should import, which is not practical (Kwoba and Kibati, 2016). Furthermore, the theory fail to explain either FDI happening amongst two developed countries having comparable strength currencies. Globalisation has led to capital markets developing worldwide, which neutralises the capital market theory in explaining cross border FDI.

2.3.1.3 Location-based approach to FDI theories

Firms take cognisance of country-level wealth characteristics like endowment in natural resources, infrastructure, labour availability, size of local market, and government policy concerning these national resources to decide on a location or where to invest (Popovici and Calin, 2014). Therefore, resource seeking, market-seeking, efficiency-seeking or strategic asset seeking lead firms to invest in foreign locations.

The location-based theory is related to the gravity approach to FDI, where FDI flows are the highest between two countries with equivalent characteristics of geography, economics and culture (Popovici and Calin, 2014). The gravity variables determine FDI flows, including the market size, distance, level of development, trade openness, and shareholder protection. However, the location-based and the closely related gravity-based approach theories face criticism as FDI flows are determined by many factors apart from common characteristics between countries. Makoni (2015) argues that having the same geographical features may lead to lesser transportation costs but not lower labour costs. Sharing of similar cultures does not guarantee increased profits and trade between two trading nations.

2.3.1.4 Institutional FDI Fitness theory

This theory by Wilhems and Witter (1998) attempts to explain the uneven distribution of FDI flows between countries. Countries get the upper hand in attracting FDI inflows when they can adapt or fit investors' internal and external expectations. Countries with an upper hand in attracting FDI inflows will also be able to absorb and retain FDI. There are four inter-related fundamental pillars of the FDI fitness theory which interact and impact each other. These pillars are market, government, and educational and socio-cultural fitness (Wilhems and Witter, 1998). The government plays the most prominent role in attracting FDI by adopting friendly protective regulations to manage markets, ensuring openness of the economy, minimal trade interventions, fewer exchange rate interventions, low corruption, the rule of law, and transparency (Popovici and Calin, 2014). Investors will shy away if political instability and policies are hostile and unfavourable, hence avoiding risky ventures. The market provides physical and financial capital, accounting for institutional FDI fitness theory's economic and financial aspects. Firms, therefore, invest where there are well functioning financial markets. Education provides the economy with various skills needed to run projects, and therefore, key to attracting FDI. Research and Development (R&D) creativity is enhanced, and processing of information improved when education level in a country is high. The FDI operations productivity and efficiency are therefore impacted positively by education. Socio-culture factors represent citizens' ability to respond to different socio-cultural and business modes influenced by educational success, foreign cultures exposure, and integration into the global economy. A country that responds well to the different socio-cultural and business ways quickly has more capacity to attract FDI. Of the four FDI fitness fundamental pillars, socio-cultural fitness is the most complex and time-intensive to change (Makoni, 2015). Foreign investors will also decide on allocation based on perceived cultural proximity, i.e., cultural ties between countries lead to more investment preference.

2.3.1.5 Dynamic Macroeconomic FDI Theory

The institutional FDI fitness theory is closely related to the dynamic macroeconomic FDI theory, which attributes investments timing to variations in the macroeconomic environment

(Lall, 1979). The timing of investment is contingent upon the existing foreign country's macroeconomic environment.

The macroeconomic factors that affect the FDI flows include government policies, GDP, market size, domestic investment, the real exchange rate, the inflation rate, interest rate, productivity and openness of the economy. Therefore, foreign investors require to understand the investment environment and associated risk in the foreign country.

2.3.1.6 The Eclectic Paradigm Theory

The capital market theory, location-based approach to FDI theories and the theory of institutional FDI fitness are all macroeconomic theories explaining FDI behaviour. The macroeconomic FDI theories look at the value of the investment stocks or the size of the flows or investment position. Furthermore, the microeconomic FDI theories examine the impacts of the FDI investments to the investor, country of origin and host country arising from the operations (trade, employment, production, and capital flows and stocks) of the MNCs. As such, the microeconomic FDI theories seek to explain why firms decide to invest in certain specific locations (Makoni, 2015). The microeconomic theories explain FDI behaviour where FDI motivations are examined from the investor's perspective (Lipsey, 2004). The microeconomic theories include the eclectic paradigm theory, firm-specific advantage theory, imperfect markets (monopoly) model, the internalisation theory, and oligopolistic reaction theory. The eclectic paradigm theory is also referred to as the ownership, location, internalisation (OLI) model, associated with Dunning (1993). The majority of the microeconomic FDI theories are founded on imperfect markets that influence firm behaviour. Therefore, examining the eclectic paradigm theory is considered representative, as it is the most well-known FDI theory.

The eclectic paradigm (OLI model) integrates the internalisation, international trade, and imperfect markets (monopoly) theories and supplements them with the location-based theory.

The integration of the various theories ensures that the determinants of FDI are included as much as possible. Demirhan and Masca (2008) contend that each FDI theory does not have the ability to act as a self-contained general theory, which could collectively explain all types of FDI.

The OLI theory explains why MNEs undertake cross-border activities (engage in FDI). Firms undertake cross border activities mainly owing to ownership advantage, location advantage and internalisation advantage. The ownership advantages include human resources, natural resources, and capital, intangible assets like entrepreneurial skills, management skills, information and technology, and marketing skills. The net ownership advantages result in production cost decreases enabling the firm to be more competitive abroad. The ownership advantages are emphasised in other microeconomic FDI theories, including firm-specific advantage theory (Hymer, 1976) and imperfect markets (monopoly) model (Kindleberger, 1969). The location advantages are cultural, legal, political, and institutional environment.

The institution environment plays a crucial role in attracting or diffusing FDI flows. For example, corruption in Kenya has been associated with many ills and is claimed to curtail investments. Corruption can positively or negatively influence foreign investment decisions of multinational firms, depending on economic activity settings created that may favour or discourage investment decisions (Gherghina *et al*., 2019). Corruption may prevent FDI from contributing to human progress and development. Hence, FDI tends to be attracted more to countries with higher institutional quality than to countries with poor institutions.

The internalisation advantage happens when the firm having the ownership advantage itself engages in the foreign business, rather than leasing the advantages to another firm (Boddewyn, 1985). By directly engaging in business, the firm makes more profit. Firms opt to diversify their activities between their home country and abroad, considering the ownership advantages accessible to them. The cost of production is hence reduceable, and benefits accruing from investments are maximised. When a firm possesses both the ownership and internalisation advantages, it becomes profitable if it engages in production using inputs from the investment country destination, such as human capital and natural resources. If production owing to ownership and internalisation advantages does not occur, exports would be made to the foreign markets and the firm's local market supplied through domestic production. The firm must also possess the location advantages of culture, legal, political, and institutional environment for the FDI to occur. The three advantages are interrelated and must occur simultaneously for FDI to happen (Boddewyn, 1985). The probability of participating in FDI and international production is higher when a country's firms enjoy more ownership advantages owing to the bigger urge to internalise them and exploit them outside their country to make more profits.

The OLI eclectic paradigm theory faces criticism in that its three advocated advantages are never unique for any firm. Hence, it is ideal for researchers to determine the FDI flows by incorporating the other theories' views that acknowledge the significance of the host country characteristics. The OLI theory may successfully explain the initial changes in multinational firm decision to invest abroad but fails to explain the subsequent increase in FDI, which may be owing to some of the OLI factors (Boddewyn, 1985). The OLI theory might also face challenges of applicability in LDCs where monopolistic firm-specific advantages like high knowledge content do not exist, (Makoni, 2015). Nayak and Choudhury (2014) contend that the dynamic interaction between GDP and economic policies of a country can affect domestic and foreign firms' ownership advantages.

Dunning's OLI paradigm assigns a basic role to financial aspects in deciding whether to undertake FDI (Forssbaeck and Oxelheim, 2008). A financial strategy that is strong helps a firm lower the discount factor of investment, enabling it to maximise the availability of capital by minimising its cost, ultimately increasing its FDI engagement. Therefore, a firm will undertake FDI when it has a solid financial position, such as competitively priced equity, a stock market that is more liquid, strong investment credit ratings, and better taxation and subsidy terms. Therefore, finance-specific variables are essential in explaining FDI and need to be included in Dunning's OLI model.

The economic and non-economic factors create a conducive environment that attracts FDIs. Firms take cognisance of country-level wealth attributes such as endowment of natural resources, government policy, infrastructure, availability of labour, and local market size regarding these national resources to decide on a location or where to invest (Popovici and Calin, 2014). The market, government, educational advancement and socio-cultural fitness are four inter-related fundamental pillars of the FDI fitness theory which interact and impact each other (Wilhems and Witter, 1998). The government plays the most prominent role in attracting FDI by adopting friendly protective regulations to manage markets, ensuring openness of the economy, minimal trade interventions, fewer exchange rate interventions, low corruption, the rule of law, and transparency (Popovici and Calin, 2014). The eclectic paradigm theory (Dunning, 1993) identified location (geography), human resources, natural resources, ICT, capital, and cultural, legal, political and institutional factors as important when firms make FDI decisions.

The review of the FDI theories reveals several notable and generally agreeable factors that determine FDI flows. These factors include economic growth (market size), exchange rate, capital, inflation rate, interest rate, risk (political, economic and social), the openness of the economy, and domestic investment (infrastructure).

2.3.2 The determinants of infrastructure development

The literature is scarce with theories explaining the determinants of infrastructure development.

However, FDI and economic growth are believed to contribute to infrastructure development. Owusu-Manu *et al.* (2019) note that FDI inflow has assisted many developing countries to sustainably develop infrastructure from the time of the 1997 global economic crisis. Bakar *et al.* (2012) note that FDI plays a critical role as it generates economic growth by increasing the domestic capital formation in the economy.

Lack of financial and technical capacities cause inadequate and poor infrastructure in developing countries. The provision of physical infrastructure (transport, energy, ICT and water) is a key mandate of governments and requires a vast number of financial resources as they are costly. This investment-debt scenario is realistic in Kenya, where heavy investment in infrastructure has led to a huge debt burden. Financial resources are required for development of infrastructure and for maintenance purposes to sustain the infrastructure's optimal utilisation. It then follows that factors that influence the availability of finance indirectly impact investment in infrastructure. Rao (2018) argue that reduction in macroeconomic risk factors is key in unlocking bank finance for infrastructure projects. The interest rates, commodity prices (inflation), unemployment rates (influenced by education levels), and exchange rates are some of the macroeconomic risk factors.

Hulten (1996), while comparing the growth experiences of Africa together with that of East Asia, found that inefficient use of infrastructure by low and middle-income countries result in a depressed economic growth resulting from a much smaller benefit arising from infrastructure investments. This implies that infrastructure must be used efficiently, and therefore maintenance is important to ensure optimal utilisation. Lack of proper maintenance of infrastructure has been found to bring about premature depletion of the infrastructure and lost concomitant opportunities. Increasing maintenance spending does help reduce power losses and outages, telephone faults, potholes on roads, and therefore, enhance the productivity effects of public infrastructure on private production (Agénor and Moreno-Dodson, 2006).

The developing countries have an economic problem of not having adequate national savings to fund their investments (Demirhan and Masca, 2008). Apart from loans, they are in perpetual need of foreign capital in the forms of direct and indirect investments. Cerra *et al*. (2017) maintain that financing infrastructure projects are a limitation to many governments, especially in the developing world. Infrastructure projects are expensive to construct, and maintenance is not cheap either. Governments have sought innovative funding mechanisms to save limited public funds and encourage alternative infrastructure financing through PPPs and other private contributions to overcome the financing challenge. The PPP may involve infrastructure management, financing or ownership (part or whole). This lessens the burden to the government that used to bear all the financing costs.

Infrastructure investment depends on the availability of public sector funds, participationof the private sector, and interdependence among types of infrastructure, leading to a tendency for countries to adopt broad-ranging infrastructure strategies (Cerra et al., 2017). The decision to invest today in infrastructure depends on past trends of infrastructure investments (Chingoiro and Mbulawa, 2016).

2.4 Conceptual and Empirical Literature Review

The relationship between FDI and infrastructure has been studied widely with mixed results. The two variables have also been found to influence the economic growth of countries.

2.4.1 Foreign Direct Investment and Infrastructure Development

2.4.1.1 Infrastructure Granger causes Foreign Direct Investment

Investigations of causality hypotheses are readily available in the literature, with controversial and inconsistent outcomes in most cases (Pradhan and Bagchi, 2013). This is attributed to disparities in country-unique studies, study periods, methodologies, and the diverse proxies representing infrastructure and other variables used in the analyses.

All in all, the causal relationship from infrastructure to FDI is believed to be positive. Infrastructure encourages foreign firms to invest in foreign markets and take advantage of benefits accruing from good, affordable, and reliable infrastructure. Generally, infrastructure Granger causes FDI.

Causality in econometrics is to some extent distinct from the concept in ordinary use, as it refers more to the capability of one variable to cause or predict the other (Majumder, 2016). According to Granger (1969) test that defines causality, Y variable Granger-cause X variable if X variable can be predicted more accurately if past values of the Y variable are used than when not used. Economic policy analysis has applied this test extensively and the results used in policymaking.

Many studies have demonstrated that infrastructure influences FDI positively or negatively amid varying degrees of significance. FDI inflow into SSA region is predicted by infrastructure development, GDP per capita, trade openness, natural resources, economic and political stability, opportunities for participating in privatisation, business friendliness, and control of corruption (Okafor *et al*., 2017; Waikar, 2011). It is also noted that FDI in developing countries is influenced positively by main telephone lines (infrastructure), the growth rate of per capita (economic growth), degree of openness to trade, and labour cost. In contrast, inflation rate, tax rate and risk negatively impact FDI (Demirhan and Masca, 2008). The study by Demirhan and Masca (2008) estimated FDI determinants in developing countries for the period 2000-2004 by means of a cross-sectional econometric model. Infrastructure and economic growth positively and significantly impact FDI.

The size of the economy (market), infrastructure and trade openness, among other variables, has determined FDI flows in Africa. Musonera *et al.* (2010) study of the East African Community bloc (Kenya, Tanzania and Uganda) assessed the institutional FDI fitness model using a sample of data from 1995 to 2007. The results of the evaluation showed that FDI inflows for Uganda and Tanzania were triggered by infrastructure, the size of population, the size of the economy, financial market development, and trade openness. FDI inflows were also predetermined by other economic, financial and political risks. Gilmore *et al*. (2003) reveal that FDI inflow to a country is determined by infrastructure, transport costs, technology, political stability, cultural closeness, and resources. Other factors include economic policy, emphasis by the government on FDI and financial inducements, other forms of foreign market entry preferences, size, and growth of the destination country market. With a small sample size (1995-2007), using many explanatory variables might have led to reduced degrees of freedom that might have led to misleading study result statistics such as R-squared, regression coefficients and p-values.

Infrastructure has been shown in studies to facilitate other factors of production. Infrastructure complements by raising the productive capacity of other inputs over the long-run (Cerra *et al*., 2017). Moreover, infrastructure helps attract FDI to an economy and accelerates the rate of economic development (Bakar *et al*., 2012). To that extent, investors look for opportunities where they can lower the cost of production and maximise benefits. As such, good infrastructure provides investors with an ideal environment to do business. Therefore, benefits derived from infrastructure development to FDI is further felt through economic growth.

Infrastructure services (transportation, sanitation, energy, and water) directly benefit households, potentially boosting their productivity and improving their welfare. Infrastructure services also support firms by lowering their cost of production, expanding market opportunities, thereby positively affecting firms' output and competitiveness and indirectly leading to the growth of the economy (Snieska and Simkunaite, 2009).

Infrastructure availability can attract FDI and additionally accelerate the rate of economic growth in a country. Therefore, infrastructure investment can be used to enhance FDI, which can further improve economic growth. Bakar *et al.* (2012) studied the role of infrastructure in determining FDI inflows in Malaysia. The study used annual time series data (1970-2010) where real government expenditure per real GDP was used to proxy infrastructure while net FDI inflows represented FDI. Other variables in the equation were trade openness, human capital and market size. The ordinary least square (OLS) method was used in the analysis. Infrastructure was found to be significant and affected FDI inflows positively. The study recommended more attention be given to the development of hard and soft infrastructure to attract FDI to Malaysia. The use of government expenditure to proxy infrastructure is termed inferior to proxying through physical infrastructure. Physical infrastructure possesses more significant explanatory power than monetary measures of infrastructure.

The cost of communication, transportation and energy is reduced when good, affordable, reliable, and adequate infrastructure is provided to the economy. Firms will invest in countries that have adequate, cheap and good infrastructure to support their production activities, ultimately leading to higher profits. Ansari *et al*. (2010) tested the income-expenditure hypothesis of three SSA countries (South Africa, Kenya, and Ghana) by applying Granger and Holmes-Hutton statistical procedures. The study revealed decreases in transactional and transportation costs as development is made on physical infrastructure. In a similar study, Siddiqui (2007) study revealed that investment in the transport sector reduced transport costs related to passenger movement and positively impacted macro-aggregates such as growth and exports. A similar study concluded that infrastructure raises international competitiveness and helps attract foreign investment (Henderson, 2002). In addition, it is documented that infrastructure investments enhance activities of the private sector by reducing costs of production, opening new markets, as well as providing new opportunities for production and trade (Siyal *et al.*, 2016).

Wekesa, *et al.* (2016) studied the effects on FDI inflows in Kenya as determined by energy, transport, communication and water and waste infrastructure development on. The research used multiple regression analysis where annual time series data (1970-2013) was utilized. The study found a positive effect on FDI inflows emanating from water and waste infrastructure, communication and transport. Energy infrastructure had a positive and insignificant effect on FDI inflows. The study found variables were I(0) and others I(1), but researchers used the Johansen cointegration test to establish the existence of a long-run relationship between the dependent and independent variables. For a study with a sample of 44 observations (1970-2013), and since the variables of the study were I (0) and others I (1), the ideal method to have used to determine cointegration and long-run relationship was the ARDL technique (Bhatta, 2018).

Nyaosi (2011) investigated the impact of infrastructure on FDI in Kenya for the period 1980-2008 using OLS, where an error correction model (ECM) was applied to measure the short-run dynamic relationship. The PCA was used to capture the overall effect of infrastructure on growth. Variables used to represent infrastructure included (1) railway (railway lines per tonne-kilometre); roads (paved roads proportion of the total road network); air transport (per capita passenger carried and air freight in million tonne-km); (2) communication (mobile telephone subscription per thousand people, internet subscription per thousand persons and fixed telephone lines per thousand persons); and (3) energy (energy use per capita - kilogramme oil equivalent and energy consumption per capita kilowatt-hour (kWh)). The study showed that a one-unit rise in infrastructure index caused FDI to increase by 0.32 per cent in the long-run, while the impact of GDP on FDI was indeterminate. In the short-run, the infrastructure index is positive but statistically insignificant. In that study, the strategic importance of infrastructure sub-sectors on FDI was ignored.

The impact of different sub-sectors of infrastructure on FDI has also been studied in Africa. The physical infrastructure effect on FDI can be negative depending on the quality, cost and availability. The investment climate is brought about by the reduction in transaction costs emanating from better infrastructural facilities. Communication infrastructure is crucial to foreign firms investing in a country as it helps in coordinating cross-border activities. The cost and availability of telecommunication infrastructure are therefore important for FDI. Similarly, efficiency in manufacturing is supported by a reliable and affordable energy Infrastructure. Access to new markets is facilitated by good transport infrastructure, which reduces operational costs. Poor, costly and unreliable infrastructure will inevitably discourage foreign firms from investing in a country. Ogunjimi (2019) found that telephone lines and electricity did not have an impact on FDI in the short-run. Electricity, however, influenced FDI in the long-run. The study of Owusu-Manu *et al.* (2019) for Ghana found that the growth in the demand of electricity does not Granger cause FDI net inflows. Gholami *et al.* (2003) could not find significant causality from ICT to FDI in developing countries. They contend that the ICT capacity must be built up to attract FDI in developing countries. As such, studying the impact of individual types of infrastructure on FDI is important for policymakers.

Asongu and Odhiambo (2019) studied the interaction between ICT, FDI and economic growth for the period 1980-2014. The study involved 25 countries from SSA. Economic growth was represented at three levels, that is, GDP per capita, real GDP and GDP growth, while ICT variable was derived from internet access and mobile phone penetration. The research found a negative effect of ICT on FDI when ICT was proxied by mobile phones penetration. The study noted that when ICT penetration is increased past specific thresholds, the economic growth dynamics realise zero net effects, and beyond which negative effects are achieved. In order to have economic justification and policy relevance, the established thresholds should be contained within the determined statistical limit. The study determined that 36 to 48 mobile phone penetration per 100 people is the established threshold in SSA. The study recommends that other policy initiatives complement pro-ICT policies to facilitate desired outcomes. The study cites some policies that can complement ICT policies, including enhanced financial access, improvement of human resources and institutional development. This study, however, fails to identify the most preferred measure of economic growth among the three measures considered including GDP per capita, real GDP and Gross GDP growth. The reason for using all three measures to represent economic growth is not clearly explained.

Nguea's (2020) study explored the effects of the development of communication, energy and transport infrastructure on FDI in Cameroon using the autoregressive distributed lag (ARDL) approach using time series data for the period 1984 - 2014. The dependent variable was the ratio of FDI net inflows over GDP (% of GDP), and the explanatory variable was infrastructure. Fixed telephone subscriptions, electric power consumption, and rail lines represented ICT, energy and transport infrastructure. The findings showed the effect on FDI to be positive and significant from communication infrastructure, negative and significant impact from energy infrastructure, and an insignificant negative impact from transport infrastructure. Poor infrastructure is costing Cameroon FDI inflows that would have supported economic growth. Using rail lines to represent transport may be counterproductive for a study on Kenya as the government concentrates more on improving road infrastructure. Insignificant investment in rail development has been realised since independence in 1963, with some rail routes having been abandoned.

In a similar study, Adenikinju (2005) studied the cost to the business sector caused by power outages in the Nigerian economy. The study found that the bad state of electricity supply has inflicted on the business sector high costs that have afflicted the Nigerian economy. The study noted that firms spend 20 per cent to 30 per cent of their original investment to acquire facilities to improve the reliability of electricity supply. Consequently, the unreliable power has negated the cost competitiveness of the manufacturing sector in the Nigerian economy. Unreliable and costly power dissuades FDI.

The effect of infrastructure on FDI in Kenya would be expected to be positive. The efforts by the government to improve infrastructure is leading to higher levels of agglomeration economies which will attract FDI inflows as better-quality infrastructure will allow firms to operate at optimum efficiency levels.

2.4.1.2 FDI Granger causes infrastructure development

FDI supports infrastructure development. It is argued that FDI inflow has assisted many developing countries to sustainably develop infrastructure from the time of the 1997 global economic crisis (Owusu-Manu et al., 2019). As such, developing countries should create a transparent, effective and broad enabling environment for investment. This is because FDI has a causality relationship with infrastructure development.

Serdaroğlu (2016) contends that infrastructure investments are realised when aggregate demand increases owing to investment expenditures in the economy and directly contribute to GDP formation. Furthermore, the achieved infrastructure investments cause more efficient utilisation of productive inputs and may stimulate private sector economic activities. The implication is that bi-directional causality exists between FDI and infrastructure development.

Infrastructure investment depends on the availability of public sector funds, participation of the private sector, and interdependence among different types of infrastructure, leading to a tendency for countries to adopt broad-ranging infrastructure strategies (Cerra *et al.*, 2017). As most FDI flows move to the developing countries, developed countries should play a better role by facilitating the use of development partners assistance to leverage PPP investment projects. This will increase the stock of infrastructure in developing countries. The links to the rest of the world through trade and foreign investment and domestic financial depth determine the domestic finance of infrastructure. The creation of a conducive environment to attract FDI, therefore, is essential.

Investment in infrastructure development is encouraged through privatisation, commissioning or private construction and ownership of infrastructure. The private sector is encouraged through friendly policies to deliver and finance infrastructure facilities and services such as power, telecommunications, water and sanitation, and transport. The private players recoup their investments by charging for their use of the infrastructure, e.g., toll roads, water supply charges, electricity tariffs, etc. An effective domestic regulatory framework like a PPP law encourages the FDI infrastructure (Kirkpatrick *et al*., 2006).

A limited number of studies have explored the effect of FDI inflows on infrastructure development. The available literature reveals FDI influences infrastructure development. Owusu-Manu *et al.* (2019) examined the short-run effect of FDI on the economy of Ghana. The study further examined how FDI and infrastructure development market shocks can be improved. The model used the Dunning (1973) OLI model, where the dependent variable was FDI proxied by net FDI inflows. The explanatory variables were market size proxied by the growth rate of GDP per capita and population size, economic stability proxied by inflation measured as consumer prices yearly percentage change and growth of GDP, openness represented by net exports, financial development proxied by broad money as a percentage of

GDP and risk represented by exchange rate variability measured as the variance of the USA dollar to Ghanaian cedi (USD/GHS) exchange rate around its mean. The study results disclosed a significant positive relationship between FDI and infrastructure. The results showed that FDI net inflows Granger cause electricity consumption (infrastructure development). On the other hand, the growth in electricity demand does not Granger cause the growth in FDI net inflows. Therefore, it is of interest to determine whether energy infrastructure affects FDI inflows in Kenya and vice versa.

In a study to test whether institutional regulation framework influences FDI flow to the infrastructure industries in developing countries, Kirkpatrick *et al*., (2006) used an FDI equation that also consisted of variables that influence economic growth. In the study, the observed variable was FDI (private foreign investment in infrastructure). The explanatory variables were economic growth (real GDP per capita), macroeconomic stability (annual change in the rate of inflation, the annual change in the real effective exchange rate, and average tax burden), trade openness (ratio of imports and exports to GDP), infrastructure (electricity generation per capita and telephone lines per 1000 population), human capital (secondary school enrolment rate), and financial development (domestic credit to private sector/GDP). The growth in financial development captures a successful regulatory framework in a country. The study results indicated that FDI in infrastructure was positively influenced by the presence of a regulatory framework that is effective and provides credible regulation. In developing countries, foreign investors are reluctant to invest in infrastructure projects when there are weak regulatory institutions that are unpredictable and unsustainable. Therefore, poor regulation and corruption discourage FDI inflows and therefore deny the country potential infrastructure investments. Kirkpatrick *et al*., (2006) was restricted to ICT and energy physical infrastructure impact on FDI. This study evaluates the major physical infrastructure sub-sectors (energy, transport, ICT and water) impact on FDI and economic growth, and vice versa. The study results will give policymakers extra ammunition to help trigger more FDI inflows and economic growth and further promote more investment in infrastructure.

The FDI inflows can equally have a significant effect on infrastructure, where the existence of a bi-causal relationship has been determined. Majumder (2016) explored the role of infrastructure availability in determining the attractiveness of FDI inflows in Bangladesh. The infrastructure types considered in the analysis were transport, ICT and energy. The model used consisted of FDI as the dependent variable represented by the current net FDI inflow. The explanatory variables were market size (current GDP), the exchange rate (average nominal exchange rate with US Dollar), trade openness (exports % of GDP), transport, ICT, and energy. The study results showed bi-directional causality from ICT to FDI. Pradhan *et al.* (2017) obtained a similar result in their study 'Telecommunications infrastructure and usage and the FDI–growth nexus: evidence from Asian-21 countries'. Therefore, governments should strive to develop infrastructure to attract FDI inflow, which pays back by supporting infrastructure development.

Pradhan *et al.* (2013) studied the long-run relationship between FDI, transport infrastructure and economic growth in India. The study found that FDI is cointegrated with transport infrastructure, implying the existence of long-run equilibrium relationships among the two variables. The causality test confirmed the presence of bidirectional causality between transport infrastructure and FDI. The results mean that policies to attract FDI should be pursued to increase investment in transport infrastructure.

2.5 FDI Models Variables

Table 2-1: Selected FDI Model Variables and Effects

Independent variable	Explanatory variables	Proxy of explanatory variable	Explanatory variable effect	Author
FDI - FDI net inflows as a % of Gross Domestic Product (GDP)	Market size (economy)[2]	Growth rate of per capita GDP	+	Demirhan and Masca (2008)
	Inflation	Inflation rate	-	
	Labour cost	Labour cost per worker in manufacturing industry	+ (insignificant)	
	Infrastructure	Telephone main lines per thousand people	+	
	Risk	Composite risk rating (highest risk (0) to lowest risk (100))	- (insignificant)	
	Tax	Corporate top tax rate	-	
	Degree of openness	Total of export and import (both nominal) divided by the GDP (nominal)	+	
FDI – net FDI inflows	Market size	Real GDP per capita	+	Bakar *et al*. (2012)
	Infrastructure	Real government expenditure per real GDP	+	
	Trade openness	Import plus export per real GDP	+	
	Human capital (education)	Real total education expenditure	-	
FDI – FDI net inflows (% of GDP)	Infrastructure	- ICT – fixed telephone subscriptions per hundred people - Energy – electric power consumption (kwh per capita) - Transport – rail lines (total route-km)	+ - (significant) - (insignificant)	Nguea (2020)
FDI – net FDI inflows	Market size	- Growth rate of GDP per capita	-	Owusu-Manu *et al.* (2019)
	Economic stability	- Inflation measured as consumer prices yearly percentage change. - Growth of GDP	No relationship -	

[2] Growth of market size = economic growth

Independent variable	Explanatory variables	Proxy of explanatory variable	Explanatory variable effect	Author
	Infrastructure	Electricity consumption growth	+	
	Openness	Net exports	-	
	Financial development	Broad money as a percentage of GDP	No relationship	
	Risk	Exchange rate variability measured as the variance of the USA dollar to Ghanaian cedi (USD/GHS) exchange rate around its mean.	No relationship	
FDI - Private foreign investment in infrastructure	Economic growth	Real GDP per capita	+	Kirkpatrick *et al*. (2006)
	Macroeconomic stability	- Annual change in the rate of inflation - Annual change in the real effective exchange rate - Average tax burden	+(insignificant) - -(insignificant)	
	Trade openness	Total of imports and exports to GDP ratio	-(insignificant)	
	Infrastructure	- Telephone lines per thousand population - Electricity generation per capita	-(insignificant) -	
	Human capital	Secondary school enrolment rate	-(insignificant)	
	Financial development	Domestic credit to private sector divided by GDP	-	
	Regulatory framework	Kaufmann's indices	+	

As illustrated from the studies shown in Table 2-1 , infrastructure and economic growth affect FDI inflows. The effect of infrastructure development on FDI can be positive or negative, significant or insignificant. The theoretical and empirical literature review further reveal that other factors exogenous to this study impact FDI flows. These factors are market size, inflation, infrastructure, risk, tax, trade openness, human capital, labour, economic growth, macroeconomic stability, financial development, and regulatory framework. These variables have been included by researchers of FDI as control variables in the models.

From the above review, FDI is represented mostly by FDI net inflows which are the value of inward direct investment to the economy from non-residents, including reinvested earnings, equity capital and intra-company loans.

For infrastructure, some variables have been cited as not ideal in the analysis of the relationship. For example, the use of public capital such as gross domestic fixed capital formation (GDFCF) underestimates the effect of infrastructure on activities in the economy (Serven, 2010). One of the reasons researchers have used aggregated data such as GDFCF is simply because the dataset is easily available (Estache and Garsous, 2012). Furthermore, capital and public investment are weak proxies of infrastructure investment when the private sector provides the significant infrastructure in the economy. This is the case in studies increasingly undertaken in developing countries (see Calderon and Serven, 2014; Estache and Garsous, 2012; Straub, 2008; 2011; Pritchett, 2000).

Straub (2011) cites the uncertainty surrounding the use of public capital to appraise the effect of infrastructure. According to this author, the statistical strength of infrastructure is underestimated by using public capital as its proxy. One of the justifications cited by the author is poor governance, which renders the use of public investment as a proxy for infrastructure investment a weak proxy. In addition, inefficiencies in public procurement and bad governance (corruption), mostly in developing economies, have catalysed non-correspondence between public capital expenditure and provision of infrastructure services (Pritchett, 2000).

In line with the thoughts presented in the preceding paragraph, Straub (2008, 2011) points out that in the period between 1989 and 1999 (65 specifications), the proportion of studies using public capital proxies for infrastructure was 72 per cent against 28 per cent of those that used physical indicators. This perhaps lends credence to the emerging unpopularity of this proxy as the situation reversed between 2000 and 2007 (75 specifications) when only 24 per cent of studies were documented to have used public capital data as opposed to 76 per cent of studies that adopted some form of physical indicators.

In a similar study, Calderon and Serven (2014) argue that measuring infrastructure using spending flows pose statistical problems. According to the authors, this is so when the private share of infrastructure provision is substantial, or a big chunk of public investment partially goes to other allocation rather than infrastructure. The authors further contend that corruption and poor public procurement systems may also lead to less accumulation and value of infrastructure than indicated by the implied public capital expenditure. It is thus concluded that physical measures of infrastructure do not have these inadequacies, and hence studies using these measures have more realistic results than ones based on infrastructure represented by monetary measures. This observation is also supported in some related studies (see Estache and Garsous, 2012; and Straub, 2008, 2011). Mentolio and Solé-Ollé (2009) argue that core infrastructure (streetlights, highways, airports) are extra productive to economic growth than other infrastructure forms. One may safely suggest that physical infrastructure matters for economic growth and should be factored into growth models.

Snieska and Simkunaite (2009) assert that numerous models that lead to contrasting results are used to measure the effect of infrastructure. This is because of a lack of a single approach in the scientific literature to adequately define the different infrastructure components and categorise and measure their proxies. To that extent, a lack of unique methodology leads to a non-optimal examination of the effect of infrastructure investments on socio-economic development. Snieska and Simkunaite (2009) further emphasise different insights on the relationship involving economic growth and infrastructure investments, which provides wide methodological background. They point to the lack of conceptual methods adjustable to fit some countries and different lifespans. Individual country characteristics govern groups of infrastructure components and the type of impact that infrastructure exerts on socio-economic development.

Some scholars believe that assessment of the effect of individual infrastructure such as roads is beneficial since such an approach helps to assess the impact of diverse types of infrastructure on economic performance (see Ngue, 2020; Mbulawa, 2017; Pradhan *et al.*, 2013; Pradhan and Bagchi, 2013). The most significant setback is the unavailability of data on the metrics of usable roads in Africa. Other studies employ a single indicator to undertake relevant empirical analysis, although taking a broad view of infrastructure (see Pradhan *et al.*, 2013; Calderon and Serven, 2004). This simplification is done because there is a high correlation among various infrastructure measures.

2.6 Conclusion

The literature discloses that there is a contrasting relationship determined to exist between FDI and infrastructure development, and therefore necessary to determine the relationship for Kenya. One study shows the effect of energy infrastructure on FDI to be negative and the impact from transport infrastructure to be insignificant; while another study found that the growth in the demand for electricity does not Granger cause FDI net inflows in Ghana. A different study found a negative effect of ICT on FDI while another study showed the effect on FDI to be negative and significant from energy infrastructure and an insignificant negative impact from transport infrastructure.

The literature review shows existence of gaps in the study of the effects of physical infrastructure investments on FDI. The literature has shown that models that analyse the effect of a variable of interest on FDI also include control variables. The control variables include market size (economic growth), inflation, infrastructure, risk, tax, trade openness, human capital, labour, economic growth, macroeconomic stability, financial development, and regulatory framework.

From the literature review, FDI net inflows as a percentage of GDP has represented FDI in many studies. Infrastructure has been proxied in most research by physical infrastructure such as roads, internet, railways, air passengers and freight, mobile phone subscribers, energy consumption, and safe water access. The literature has shown that physical infrastructure leads to more pronounced, reliable and conclusive results than monetary measures, hence adopted in this study. It is also noted that imprecise estimates will most likely result from econometrics (especially time-series) when multiple types of infrastructure assets are considered simultaneously. Therefore, synthetic infrastructure indices are encouraged to be used. Furthermore, physical infrastructure is heterogeneous, and impacts by diverse types of infrastructure (transport, ICT, energy, or water) better captures the effect of the specific infrastructure used. The specific infrastructure type used will aid in devising appropriate policies that will be more impactful in influencing FDI inflows into Kenya and the needed infrastructure investments.

CHAPTER THREE

INFLOW OF FDI, ECONOMIC GROWTH AND INFRASTRUCTURE

3.1 Introduction

This chapter gives a synopsis of existing literature on the relationship between the inflow of FDI and economic growth. The chapter also factors in the role of infrastructure in this nexus. The chapter builds on the contents of chapter one (introduction) and chapter two (infrastructure and inflow of FDI). In chapter one, the existing situation of economic growth, FDI and infrastructure development in Kenya was presented. The chapter shows the objectives of the study, which also includes investigating the effects of FDI inflow on economic growth in Kenya. In chapter two, the literature was provided containing the definition and the relationship between infrastructure and FDI. The FDI models contain economic growth (market size) as one of the explanatory variables. This chapter mainly looks at theoretical, conceptual and empirical literature associating economic growth with FDI and infrastructure development. The methods used to analyse the relationship between economic growth, FDI and infrastructure development are also discussed in this chapter.

3.2 Understanding Economic Growth in relation to FDI and Infrastructure

The definitions and literature review on the relationship between FDI and infrastructure were provided in chapter two. This chapter defines economic growth and reviews the relationship between economic growth with FDI and infrastructure. In the few documented literature, economic growth is viewed to have various forms of relationships with FDI; the same could be said of infrastructure investment.

3.2.1 Economic Growth

Economic growth is commonly defined to mean growth in output or production. Almfraji and Almsafir (2014) see economic growth as annualised output or production at full employment (using all available labour resources in an economy efficiently). It could therefore be said that growth in aggregate demand or observed output leads to economic growth and that the latter is traditionally estimated as the percentage increase in the real GDP.

According to Pietak (2014), economic growth is the main measure of the socio-economic prosperity of a country. However, the measurement has several drawbacks, including the inability to factor black market output, and the measurement does not consider changes in the amount of time spent out of work, hence affecting the welfare of society. Furthermore, the measurement does not include the negative processes of production, such as environmental pollution.

Rahman *et al*. (2019) see economic growth as a gradual increase in the real GDP, which is an essential condition for a country's overall socio-economic development. They term it as having great power in reducing poverty, improving people's living standards, and creating jobs. The authors then conclude that this form of investment is fundamental for the development of emerging economies.

There is an opinion that economic growth results in increased demand, which creates employment opportunities. More growth means more tax revenue that increases spending on public services such as education, health and infrastructure. With more earnings realised from positive economic growth, the debt to GDP ratio is eased (Broyer and Gareis, 2013). However, economic growth has drawbacks, including negative externalities such as environmental impacts (e.g., pollution), increased crime rates and urban congestion. Economic growth might not lead to economic development as inequality in income distribution sometimes increases with growth, thereby precipitating macroeconomic and social tension.

3.2.2 The Determinants of Economic Growth

Infrastructure is thought to facilitate FDI flows, which further affects economic growth. Therefore, it is essential to examine the factors that determine economic growth. Researchers have tended to explain economic growth using various models. There has been no agreement on the main determinants of growth, and an all-inclusive model that covers all the so far identified influences is yet to be formulated (Boldeanu and Constantinescu, 2015). Boldeanu and Constantinescu (2015) assert that human resources, natural resources, capital formation, technology, efficiency, and demand are the six major factors determining economic growth. Other determinants are grouped as non-economic and include factors such as political and governmental systems, geography and demography, cultural and social factors, government efficiency, and institutions.

Classical growth theories postulate that output (economic growth) is determined by the stock of capital, labour force and land or natural resources (Mbulawa, 2017). Technological progress is a significant factor in production that increases with the accumulation of capital, and the importance remains until profits dip and capital stops being accumulated. In the growth models of Harrod (1939) and Domar (1947), together chiefly referred to as Harrod–Domar model, these authors cite the level of national savings and productivity of capital investments (capital-output ratio) as a strong determinant of growth. Infrastructure appears in the Harrod-Domar model as capital investments.

Conversely, the neoclassical growth theories economists argue that economic growth is determined by land, capital and labour (Pietak, 2014). In capitalist countries, the more these factors are utilised, the more economic growth is achieved. Technological advances are cited by neoclassical economists as crucial to economic growth. However, Barro (1990) claims that some economic growth models can lead to long-term growth without depending on exogenous changes in population or technology.

In the neoclassical's endogenous growth theory, economic growth is determined by investment in knowledge, human capital and innovation (Ribero, 1991; Lucas, 1988; Romer, 1986). As such, policy measures determine long-run economic growth and can also affect infrastructure development, education and research and development. Infrastructure, education (human capital), and R&D facilitate FDI inflows to a country. This is different from neoclassical's exogenous growth models where labour-augmenting improvement in technology, in the long-run, determines the output per worker growth rate. The factors not found in the model (exogenous factors) may be attributed to labour-augmenting advancement in technology. It is important to note the practical inverse relationship between employment and technological advancement. According to Aregbeshola (2017b), improvement in production technology would ultimately precipitate lower usage of labour, essentially because technology would reduce human capital intervention in the production process. The same applies to land, but the reverse is the case for capital, which increases with technological innovation (Aregbeshola, 2017b).

Carbonell and Werner (2018) contend that for countries to enhance growth, international organisations such as World Bank, African Development Bank (AfDB), and International Monetary Fund (IMF) recommend that technology transfer from abroad through FDI should be encouraged. The reason is that technical progress happens outside neoclassical (exogenous growth) models.

3.2.3 Studying the Relationship between FDI, Economic Growth and Infrastructure

Studies that have examined the relationship between either two or all three variables (infrastructure, FDI and economic growth) have run models that have each of the variables explained by the others (see Babajide and Lawal, 2016; and Pradhan et al., 2013). Agénor and Neanidis' (2015) methodology for estimating direct and indirect impacts of education, innovation, and infrastructure access on economic growth specified a model comprising of four equations, one for each of the four major variables. The equations were approximated both in simplified form, independently of one another, and as a whole.

The impact of infrastructure on FDI and economic growth has been modelled by introducing the flow of infrastructure services or stock of infrastructure assets as an extra input in the FDI or economic growth functions (Calderón and Servén, 2014). Aschauer (1989) expanded the Cobb-Douglas production function to include the core infrastructure defined as highways and water and sanitation systems. The endogenous growth models are utilised where the stock of infrastructure assets such as public highways are input. Calderón and Servén (2014) assert that the practice has been to model infrastructure as an input like other inputs in production where it captures the use of transport or electricity services by producers.

Fosu (2019) employed the Solow-Swan growth model, where economic growth is a function of capital accumulation, labour or population growth and technological change. He extended this growth model by presuming that technological progress can be influenced by infrastructure development, including infrastructure as an explanatory variable. Other explanatory variables were inflation lending interest rates, effective interest rate and trade deficit. Barro (1990) incorporated productive government expenditures (like infrastructure) into a constant-returns endogenous growth model.

As in production functions, infrastructure acts as an explanatory variable in FDI models. Demirhan and Masca (2008) and Cerra *et al.* (2008) regress an FDI equation having infrastructure and economic growth as some of the main explanatory variables.

3.3 Conceptual and Empirical Literature Review

The link between infrastructure development, FDI and economic growth has been researched for a considerable period. It is widely believed that infrastructure development and FDI inflows are important factors in the economic growth process of a country. It is, however, important to point out that most of the studies in this regard either looks at growth nexus through the inflow of FDI (Aregbeshola, 2018; 2014; Almfraji & Almsafir, 2014) or infrastructure and growth (Chingoiro and Mbulawa, 2016; Pradhan *et al.*, 2013; Pradhan and Bagchi, 2013). Studies that have focused on the three cardinal models are rare, especially in Africa-orientated studies. The three variables are believed to influence each other in an economy.

3.3.1 FDI and Economic Growth

3.3.1.1 FDI Granger causes economic growth (GDP)

Chirwa and Odhiambo (2016) appraised the prevailing empirical literature covering the main macroeconomic determinants of economic growth in both developing and developed countries. They conducted a qualitative narrative appraisal. The appraisal found a distinction between what propels or thwarts economic growth in developing countries compared to developed countries. According to these authors, the leading macroeconomic influencers of economic growth in developing countries include investment, foreign aid, trade, FDI, reforms, human capital development, demographics, geographic, natural resources, and monetary and fiscal policies. Others include financial, political and regional and factors. Financial and technological, physical capital, demographics, fiscal policy, monetary policy, human capital, and trade factors are the key macroeconomic factors determining economic growth in developed countries.

Looking at the interaction between FDI and growth, there is mixed empirical evidence on the effect of FDI on economic growth, and gaps remain in the literature (Carbonell and Werner, 2018). Almfraji and Almsafir (2014) reviewed several types of research that looked at the impact of FDI on economic growth between 1994 and 2012. The review showed that FDI directly and indirectly affected economic growth. In most countries covered by the research, FDI and economic growth relationship were positive, although also found negative or null in some instances. Factors that influence the FDI-economic growth relationship are adequate supplies of highly skilled human capital, good financial markets, market liberalisation, and complementarity between domestic and foreign investment.

Gherghina *et al*. (2019) explored the nexus between FDI and economic growth using a sample of 11 Central and Eastern European countries. VECM model was used to determine the Granger causalities. The study estimated a panel data regression model with GDP per capita (current prices), FDI (net inflows as % of GDP), and infrastructure (length of motorways and internet usage) as some of the variables investigated. The empirical results showed that the relationship between FDI and GDP per capita was non-linear. Furthermore, the Granger causality results from the panel vector error-correction model revealed a short-run uni-directional causal effect from FDI to growth and a long-run bi-directional causal relation between FDI and growth.

Waikar *et al.* (2011) applied simple regression analyses to determine the effect of FDI on per capita income, GDP and secondary data of 1993 – 2005 period was used where variables analysed included GDP, FDI inflows, export volumes, population and employment. The findings from the analysis revealed that FDI had a positive effect on economic growth and per-capita income. FDI was also observed to crowd out domestic investment. Foreign firms have capital and modern technology which give them a competitive advantage over local firms. Furthermore, FDI that does not utilise domestic resources, and value-adding in the host country may be detrimental to local investments.

Agbola (2014) investigated the effect of FDI and human capital on the growth of the economy in the Philippines using annual time series data (1965-2010). The results indicated that FDI had a positive influence on the economy's growth. Economic growth is attained when increased human capital and infrastructure development create adequate absorptive capacity. The relative size of government investment crowds out private investment. Therefore, to attract FDI and consequently attain sustained economic growth and development, investment by the government should be geared towards developing both infrastructure and human capital.

Belloumi (2014) investigated the causal relationship between economic growth, FDI and trade in Tunisia using the ARDL bounds cointegration approach. Annual time series data for the period 1970-2008 was utilised where FDI and trade were presented as a ratio of GDP, while economic growth was proxied by real GDP per capita. Real gross FDI inflows to GDP ratio defined FDI. The Granger procedure was used in testing the causality direction within the VECM. As is asserted by Engle and Granger (1987), variables are cointegrated if they have a valid error correction representation where an error correction term (ECT) is included in the model. Belloumi (2014) asserts that the information lost by differencing time series is reintroduced when VECM is used, hence its importance in the investigation of the short-run dynamics and the long-run equilibrium. The results indicate that economic growth, FDI and trade are bound together in the long-run when FDI is the regressand. A significant error correction term affirms the existence of a long-run relationship. In the short-run, the results find insignificant Granger causality from FDI to economic growth and vice versa, and from both trade and economic growth to each other. The empirical results for the study on Tunisia do not confirm the common idea that positive spillover externalities can be generated by FDI for the home country.

3.3.1.2 Economic growth Granger causes FDI

There is a plethora of empirical work examining the relationship between economic growth and

FDI. Most of the research results confirm that economic growth positively influences FDI. Some studies found a bidirectional causality existing between the two variables. Impressive economic growth helps attract FDIs, which in turn cause more economic development. The Government of Kenya expects to create an enabling environment that will grow the economy and attract FDI through trade agreements, legislation, infrastructure development, etc.

Okafor *et al*. (2017) and Waikar (2011) found that economic growth influences FDI in SSA. Other variables influencing FDI are infrastructure development, trade openness, natural resources, economic and political stability, opportunities for participating in privatisation, business friendliness, and control of corruption. Demirhan and Masca (2008) found that economic growth, infrastructure, degree of openness to trade, and labour cost positively influenced FDI in developing countries, while inflation rate, tax rate and risk had a negative impact.

Some results have revealed a negative relationship between FDI and economic growth. Owusu-Manu *et al.*'s (2019) study on the short-run effect of FDI on the economy of Ghana revealed a negative and significant relationship between FDI and GDP. The study revealed that a 10 per cent increase in the growth of GDP induced a 40 per cent decrease in FDI inflows. The negative and significant FDI and GDP relationship confirms the tariff-jumping hypothesis, which states that foreign MNCs establish subsidiaries abroad to supply goods and services to the host markets when imports of their products are difficult to enter those market. Put in another way, FDI suppresses local firms' growth and does not support economic growth through jobs and improved incomes. The study in analysing the relationship between FDI and economic growth included other important variables that influence both FDI and economic growth. These include trade openness, exchange rate, natural resources, infrastructure, and inflation rate.

Sarker and Khan (2020) study for Bangladesh investigated the causal nexus between FDI and

GDP. They checked cointegration in the model using the augmented ARDL bounds testing approach and explored the causality direction using the Granger causality test. The study results showed a long-run relationship between FDI and GDP. Furthermore, the error correction regression found economic growth had a negative effect on FDI. The study further found a unidirectional causality existing from GDP to FDI. The study, however, run only the two variables in the regression analysis. The study findings could have been more robust if control variables were included in the models analysed.

Gilmore *et al*. 2003 reveal that FDI inflow to a country is determined by several factors: economic policy, emphasis by the government on FDI and financial inducements, other forms of foreign market entry preferences, size, and growth of the destination country market. Fischer (1992) found a positive association between the investment rate of FDI and economic growth in Latin America and the Caribbean (LAC) and SSA countries. Muthoga (2003) investigated FDI determinants in Kenya from 1967-1999 using a linear regression model and found that foreign investors are attracted to Kenya by economic openness, GDP growth rate, domestic investment level, internal rate of return, and credit availability. The study did not include infrastructure as an explanatory variable, despite being a major factor.

Kwoba and Kibati (2016) studied the impact of the exchange rate, GDP and inflation on foreign direct investment in Kenya. The study used both quantitative and qualitative methodologies. In the quantitative method, a linear regression of a sample from 2005 to 2014 was analysed. FDI as a percentage of GDP was the regressand while the exogenous variables were inflation rate (INFL), GDP and exchange rate (EXR). EXR, GDP and INFL were discovered to have insignificant negative effects on FDI inflows. In the qualitative study, primary data consisting of 271 respondents were collected where information was gathered on their perception of FDI. People in Kenya regard FDIs as market-seeking investments, according to the study findings, such that investment will happen if a market is available for goods and services produced.

Musonera *et al.*'s (2010) study, as evidenced by resource-poor countries of Tanzania and Uganda, did not find natural resources as significant determinants of FDI inflows to Africa. FDI is attracted into Tanzania and Uganda owing to favourable government policies that ensure political and macroeconomic stability, efficient regulatory framework and that eliminate corruption. In the post-2010 era, notable ample resources have been discovered in the East Africa region, including the oil in Uganda and Kenya and natural gas and minerals in Tanzania. A study undertaken today would most likely give a different result.

3.3.2 Economic Growth and Infrastructure Development

3.3.2.1 Infrastructure Granger causes economic growth

The role of infrastructure in facilitating production processes and contributing to economic development has been debated and researched over the years. An infrastructure that is adequate in quantity, quality and is reliable is important for overall economic growth (Pradhan, 2007). The author further contends that any country that has industrialised and urbanised rapidly had infrastructure developed first. Infrastructure has multiplier effects on employment, income and investment. Demetriades and Mamuneas (2000) contend that infrastructure is a pacesetter of economic growth and a critical cause of economic development in developing countries. Investment in the economy is encouraged by infrastructure development in both demand and supply sides. Infrastructure opens the possibilities of investment on the demand side by availing needed inputs and services, and opening the market size. Investment on the demand side is supported by increasing supply elasticity and the efficacy of factors of production. Regarding the supply side, infrastructure development helps to mobilise potential savings that are used for productive investment. Financial losses and technical inefficiencies are reduced by better infrastructure services (Barro, 1990).

Infrastructure affects economic growth both positively and negatively (crowding-out). The crowding-out effect emanating from private capital and hence economic growth emanating from infrastructure investment happens when the investment in infrastructure becomes too commanding in an economy (Shi *et al*., 2017). Growth in public infrastructure investment at first raise the rate of economic growth but cause it to fall beyond a certain threshold (Barro, 1990). The economic impact arising from infrastructure investment has a diminishing marginal rate of return (Rodrigue, 2020).

Roadrigue (2020) argues that similar amounts of infrastructure investments have different multiplying effects depending on a country's level of economic growth. This can be categorised into three scenarios. In the first case, there is a high impact from new infrastructure investments in an underdeveloped region with limited existing infrastructure. The new infrastructure provides economic opportunities such as labour, resources and markets. In the second case, additional infrastructure result in fewer benefits, and the infrastructure is said to have an average multiplying effect on economic growth. Most developing countries belong to this group. Despite the fewer benefits obtained, notable gains are experienced where existing activities are more productive and competitive owing to better capacity, connectivity and reliability of the new and recently invested infrastructure. The last case consists of infrastructure investment having low multiplying effects and mainly involves infrastructure upgrade and maintenance. The upgrade and maintenance are undertaken to ensure the infrastructure does not lose the capacity and reliability to support the economy. The infrastructure investments with a low multiplier effect are mostly found in developed economies. The above three scenarios indicating diminishing marginal returns from investments made on infrastructure imply that it is fallacious to equate the impacts of infrastructure investments on economies with different levels of development and dissimilar quantities of infrastructure investment.

Kodongo and Ojah (2016) cite four instances where infrastructure is believed to induce economic growth. According to these authors, infrastructure is a factor of production as it is regarded as part of a country’s physical stock of capital. National output is impacted by the changes in the stock of infrastructure. Hence, it directly induces economic growth. Infrastructure supplements other factors of production and therefore, expands the production frontier, profitable investment opportunities or improving total factor productivity by lowering input costs. Infrastructure is thought of facilitating the build-up of factors of production and therefore, indirectly affecting economic growth. Lastly, infrastructure investment directs industrial policy towards the desired path or stimulates aggregate demand in the process affecting economic growth. The above impacts on economic growth are more pronounced when stocks of infrastructure assets are relatively low, especially in developing countries, especially in SSA (Agénor and Moreno-Dodson, 2006). The results of this study will give a rough idea of the level of stocks of infrastructure assets in Kenya.

The SDGs numbers 6 to 9 underscore the importance of infrastructure and economic growth (United Nations General Assembly, 2015). The SDG Goal no. 6 acknowledges that poor people's food security, livelihood choices and educational opportunities are negatively impacted by inadequate water, poor quality of water, and poor sanitation. In contrast, the SDG Goal no. 7 stipulates that lives and economies are transformed through the provision of sustainable energy. The SDG Goal no. 8 endeavours for the promotion of decent work for all, full and productive employment, and sustainable economic growth that is also sustained and inclusive. Hence achievement of economic growth that is also sustainable is encouraged. SDG no. 9 identifies infrastructure investment, information and communication technology, transport, energy and irrigation as paramount in the realisation of sustainable development and communities' empowerment. Gherghina *et al*. (2019) contend that noteworthy growth drivers include SDGs that are a composite of transport infrastructure, innovation, information technology, education, poverty, and income distribution. Therefore, infrastructure development and the pursuance of sustainable economic growth is paramount.

To achieve the SDGs for the improvement of the lives of communities, it is paramount to develop infrastructure. Public investments in roads positively affect the productivity of a community of people. Improved road network reduces road accident fatalities and promotes public safety. Healthcare is improved, and communicable diseases are reduced through good water systems, efficient sanitation and good waste management. It is also noteworthy that improved transport infrastructure supports market integration and minimises trade costs, leading to price convergence, reduction in the volatility of prices and the comparative advantage arising from optimal allocation of resources (Banerjee *et al*., 2012). Achieving human development, especially in education and health, requires supportive infrastructure – roads to access educational schools and health centres, electricity to serve schools and health clinics, and water and sanitation to prevent diseases (Snieska and Simkunaite, 2009).

Telecommunications include radio networks, packet-switched networks, wireless networks, the internet, public switched telephone networks (PSTN), and television networks. Telecommunications help disseminate information within the society, thereby improving the achievement of social cohesion, galvanising the service industry's efficacy and improving governance architecture (Kaur and Malhotra, 2014). It is also noted that telecommunications lower the cost of doing business by lowering the cost of collecting information, hence reducing the incidence and negative effects of information arbitrage in the financial market. In addition, mobile banking supports financial inclusion and inclusive growth by facilitating customers to transfer funds, purchase financial products, access account information, and trade stocks – all remotely. Furthermore, accessible and affordable telecommunications promote social development like health, improved citizen participation in civil society and enhances access to better education. Gherghina *et al.*'s (2019) study showed a positive effect of information technology and transport infrastructure on the economic growth.

Water is vital for an economy and determines the quality of life of citizens. Water is used in all walks of life, in schools, hotels, hospitals, factories, shopping centres, farms, recreational facilities, to restaurants. More importantly, water infrastructure is needed to boost productivity in the agriculture, hydropower, tourism, and transport sectors. Improved access and affordability in the utilisation of basic infrastructure and services are found to contribute meaningfully to reduce child and maternal mortality rates (Calderon and Serven, 2014). Access to clean water and sanitation is a measure in the human development index that gauge quality of life. Snieska and Simkunaite (2009) suggest that the level of diseases is reduced by portable water systems, while the health and aesthetics of the environment are improved by waste management.

Infrastructure is associated with employment and income creation, environmental conservation and enhances gender equality. Calderon and Serven (2014) show the effect of infrastructure investment on employment, income generation, environment, and gender equality. Electrification is credited with rising female employment. Women's time from home to work is freed when cooking by wood-burning is replaced by electricity which is also used for lighting. Production of goods and services at home for the market arises as new opportunities, either through self-employment or micro-enterprises. Across all genders, electricity access releases extra time for schooling and enables the utilisation of computers and other life-enabling gadgets.

Rostow (1960) argues that the third stage of growth, which he calls 'take-off', requires the accumulation of social overhead capital (infrastructure). During the 'take-off' state of economic growth, expansion of the forces routing for economic progress eventually dominates society. It is believed that Africa faces infrastructure stock deficits that make optimal levels of production difficult to achieve. Gutman *et al*. (2015:11) estimate that USD 93 billion is needed in Africa per year to fill the existing infrastructure gap.

In several studies undertaken mostly in developing countries, infrastructure has been proven to support economic growth. However, the research has not found uniform results on the impact of infrastructure on economic growth. Some results are significant, and others insignificant. In a study of South Asian countries, Rahman *et al*. (2019) explored the drivers of economic growth by regressing heterogeneous panel data for the period 1975 – 2016. The GDP growth rate was the dependent variable, while the growth rate of gross capital formation, trade-GDP ratio, remittance to GDP ratio, inflation rate, government consumption expenditure, FDI to GDP ratio and energy (per capita oil) consumption were the key explanatory variables. The results showed that economic growth is driven mainly by gross capital formation, energy use and remittances. All these variables had a positive and significant effect on economic growth. The study was economical in using only energy in the analysis and could have considered other physical sub-sector infrastructures such as transport, ICT and water.

In another similar study in SSA, Owolabi (2015) investigated the infrastructural development and economic growth nexus in Nigeria for the period 1983-2013 using OLS and Granger causality econometric methods. Annual time series data was used, where GFCF represented infrastructure and GDP proxied economic growth. The study showed that economic growth is positively and statistically impacted by infrastructural development. However, the Granger causality test outcomes taken during the same period revealed no mutual correlation between economic growth and infrastructural development.

Kaur and Malhotra (2014) investigated the causal relationship between telecommunication development and growth of the economy in India for the 1995 – 2005 period. The study results showed a long-run relationship between the growth of the telecommunication sector and economic growth. The study revealed an asymmetric causal relationship existing between the growth of the telecommunication sector and the growth of the manufacturing sector. The study concludes that telecommunication growth in India causes economic growth. In another study, it was argued that the growth process of a country is positively influenced by factors that affect the efficacy of savings and investment (Fischer, 1992). It could then be concluded that infrastructure facilitates and hence, increases the efficiency of investments.

Banerjee *et al.* (2012) estimated the effect on regional economic outcomes emanating from access to transportation networks in China during a period of rapid growth of income (1986-2006). The findings of the study showed that easy access to transportation networks has no effect on per capita GDP growth, but it has a reasonable positive causal impact on the levels of per capita GDP across sectors. In this study, it is not apparent why both per capita GDP growth and per capita GDP were used separately as dependent variable to represent economic growth. Majority of recent research has used per capita GDP growth as proxy for economic growth.

Aschauer (1989) found that public infrastructure capital positively affected total factor productivity in the United States of America, thereby implying that improved productivity and economic growth were attributed to enhanced public capital stocks. Public infrastructure investment is therefore important for a country's economic growth. However, Evans and Karras (1994) found results that contradicted the findings of Aschauer (1989). Evans and Karras (1994) investigated the degree of contribution to private production emanating from government capital and current government services. The investigation found that the direction of causality contradicted Aschauer (1989) findings with a significant negative effect of public capital on economic growth.

An economy's growth potential is increased through infrastructure investment as the productive capacity of an economy is increased (Foster and Briceño-Garmendia, 2010). Following this argument, Pradhan and Bagchi (2013) study of India examined the effects of transportation infrastructure (road and rail) on economic growth in India using the VECM. The study proxy for economic growth was GDP, transport infrastructure was proxied by road transport and railway transport, and infrastructure investment was proxied by gross domestic capital formation. The study results showed a bidirectional causality existing between road transportation and economic growth. Conversely, a unidirectional causality existed from rail transportation to economic growth. The study further revealed that substantial growth was because of the expansion of transport infrastructure and gross capital formation. Therefore, improving transportation infrastructure to ensure sustainable economic growth was important and could be achieved through an appropriate transport policy. Transportation infrastructure has been associated with economic growth for a long time (Phang, 2003). This may motivate why Kenya adopted a long-term orientation of heavy investment in constructing and maintaining the road network. However, the use of GDP to proxy for economic growth has been criticised. In the literature, GDP on its own is used to represent many variables and concepts. The use of per capita GDP growth rate has been preferred in most recent studies (see Owusu-Manu *et al.*, 2019; Agbola, 2014; Bakar *et al.*, 2012; Demirhan and Masca, 2008; and Kirkpatrick *et al*., 2006).

Mbulawa (2017) studied economic infrastructure in Botswana and its impact on long-term economic growth - using a log-linear model and diverse measurements of growth and infrastructure in the examination of the relationship between growth and infrastructure. GDP per capita at current prices was used to represent economic growth, while improvements made to the road and the railway networks represented infrastructure. Using VECM and OLS, the study found that economic growth in the long-term is elucidated by infrastructures such as road maintenance and electricity distribution. Long-term economic growth has more impact on infrastructure than infrastructure on long-term economic growth. As such, the study supports the infrastructure-led growth hypothesis, which has been the Kenyan government's primary argument and strategic focus.

Broyer and Gareis (2013) examined the multiplier effect of infrastructure investment by governments (transport sector's capital formation) in the euro area. The study estimated a vector autoregression (VAR) model for Spain, Germany, Italy, and France (four major economies of the euro area). Investment in public infrastructure was measured as GCF (government gross capital formation) in the transport sector, while GFCF (total gross fixed capital formation) minus GCF measured private investment. GDP represented economic output. The variables were denoted in real per capita terms using the GDP deflator. The variables were expressed in logs during the analysis of the models. The estimated VAR was of order one. The results of the study showed increased employment, private investment and output caused by increased investment in public infrastructure. The elasticities of output associated with investments in transportation infrastructure were found to be enormous. The study concluded that to reduce the public debt burden and support GDP, a suitable policy lever would be to develop infrastructure. The Kenyan government might be reading from the script of this conclusion where infrastructure development would reduce the public debt burden and economic growth. The use of GFCF to proxy infrastructure is argued to produce unreliable results compared with physical infrastructure (see Calderon and Serven (2014). GDP is also not a preferred measure of economic growth, where recent research has opted for the per capita GDP growth rate.

Several other studies have shown that infrastructure development leads to economic growth and, therefore, substantiates the Kenyan government's determination to develop infrastructure to achieve economic growth. Snieska and Simkunaite (2009) studied the Baltic States and found a high correlation between infrastructure and growth variables. Economic growth was represented by GDP per capita in purchasing power parity terms, while infrastructure variables included transport (paved road length in kilometres per 1000 people), communication (fixed-line and mobile phone subscribers per 1000 people), and water (resident population connected to wastewater collection and treatment). In Lithuania, the impact of transport infrastructure on growth is positive, while ICT negatively influences growth. In Latvia and Estonia, telecommunication and transportation sectors correlate strongly and positively with economic growth, while the impact of sanitation was inverse. The findings indicate that differing results of the relationship between infrastructure and economic growth which have been measured differently can be found for countries having the same income level. There is a need for comprehensive research using the most dependable methodologies and the right variables to reveal the right relationship between economic growth and infrastructure for Kenya. Snieska and Simkunaite (2009) study left out energy infrastructure, which is an important physical infrastructure thought to influence economic growth and FDI inflows.

In another research, Serdaroğlu (2016) studied Turkey, where the significance of investment in public infrastructure to the economy was investigated. The study employed a Cobb-Douglas production function and found out that capital investments in total public infrastructure significantly enhanced economic growth. Public infrastructure investment was represented by public physical infrastructure capital, while economic growth was represented by real GDP. After finding that infrastructure positively enhances economic growth, the study suggested increasing the quality and quality of public infrastructure to support private sector investments. The results imply that countries should give importance to public infrastructure investments to prosper.

Siyal *et al*. (2016) analysed the relationship between infrastructure investment (expenditure on development), institutional quality, and people's living standards in Pakistan. Development expenditure was used as a proxy for infrastructure investment, while changes in people's institutional quality and living standards represented a change in economic growth. In the models, GDP per capita was calculated as the current GDP divided by the population. The study involved carrying out empirical estimates comprising unit root test, Johansen-Juselius (JJ) cointegration method, VAR analysis and Granger causality tests. The findings revealed the existence of a long-standing relationship between the three variables. The study also found a uni-directional relationship from infrastructure investment to institutions' productivity and the living standards of people, hence the positive effect on economic growth. However, infrastructure development did not significantly play a part in the economy's long-run growth because more development expenditure is directed to physical infrastructure rather than social infrastructure like education and healthcare. Therefore, investment in infrastructure supports institutions to increase their skilled labour (social infrastructure) productivity and reduce their cost and time (physical infrastructure). Consequently, economic growth in the country is increased, and people get higher per capita income. The Johansen-Juselius (JJ) cointegration method is not preferred when the order of integration of variables of the study are a mixture of I(0) and I(1).

Other researchers have demonstrated the effect of infrastructure on economic growth realised from increased productivity. Nadeem *et al*. (2011) showed that public investment in physical and social infrastructure (rural roads, village electrification, irrigation, rural education, and health) positively influenced total factor productivity. Similarly, Serven’s (2010) study disclosed that infrastructure could affect total output directly once infrastructure services are in production as an input and when they raise total factor productivity through reduced costs. This approach is argued by Serven (2010) to enhance the efficient use of productive inputs.

Using the VECM model, Shi *et al*. (2017) found diverse backing across time periods and regions for the contribution afforded by investments in infrastructure (in telecommunications, electricity, railway, and roadway) to economic development. Infrastructure was proxied by urban landline telephone subscribers, electricity generation capacity, length of the railway, and length of the road. Economic development was represented by the growth rate of real GDP per worker. Another variable included in the model was real FDI. Variables were expressed in logs in the model's estimation. The study results found that the impact of road construction, especially in regions lagging in development, is negative. The explanation for the negative relationship is that the crowding-out impact of private capital and hence, economic growth emanating from infrastructure investment arises when infrastructure investment becomes too dominant. The point to note is that infrastructure spending has not always led to faster economic growth. Overspending in some types of infrastructure needs to be avoided. Shi *et al*. (2017) considered some physical infrastructure (ICT, energy and transport) but excluded examining water infrastructure impact on economic growth.

Egbetunde and Fasanya (2014) did a comparable study for Nigeria using the ARDL bounds testing approach to analyse the impact of public expenditure on economic growth. While applying the bounds testing (ARDL) approach, the study examined the long-run and short-run relationship between economic growth and public expenditure using annual time series data. In the analysis, economic growth (output) is proxied by GDP. The analysis concluded that economic growth is not stimulated by public spending probably because of more expenditure on recurrent than on capital spending (expenditure fungibility). The study noted that the capital budget is three times less than recurrent expenditure in Nigeria. The high cost of governance is also held responsible. To ensure that public expenditure facilitates economic growth, Egbetunde and Fasanya (2014) recommended increment in expenditure on infrastructure, social and economic activities, while budget implementation is monitored to ensure effective performance. The government needs to motivate and facilitate private sector initiatives to stimulate economic growth.

The effect of infrastructure development on economic growth is expected to be positive for Kenya. Kenya is believed to possess infrastructure stock deficits that make optimal levels of production difficult to achieve. Hence, the growth in public infrastructure investment will raise the rate of economic growth. The impact of infrastructure on economic growth is expected to be more pronounced in a developing country like Kenya, where the stock of infrastructure assets is relatively low. Therefore, it is expected that infrastructure Granger causes economic growth in Kenya.

3.3.2.2 Economic growth Granger causes infrastructure development

A possible bidirectional causality exists between economic growth and infrastructure development. Investments in infrastructure stimulate growth and, in turn, lead to higher demand for infrastructure (Snieska and Simkunaite, 2009).

Pradhan *et al.* (2013) studied the long-run relationship between FDI, economic growth and transport infrastructure in India. The study found that economic growth is cointegrated with transport infrastructure, implying the existence of a long-run equilibrium relationship. The causality test affirmed the presence of bidirectional causality between transport infrastructure and economic growth. The results mean that economic growth needs facilitation to increase investment in transport infrastructure.

In another study, Kumo (2012) investigated the causality between economic growth and economic infrastructure (physical infrastructure) investment in South Africa. The study used the ARDL bounds testing approach for cointegration to assess the short-run and long-run relationships among the variables. The findings showed the existence of a strong bidirectional causality between economic infrastructure investment and GDP growth. The findings also revealed a long-run cointegrating relationship between economic growth and economic infrastructure investment. The finding can be interpreted to mean that the long-term economic growth in South Africa is influenced by economic infrastructure investment, while increased growth pays back by enhancing public infrastructure investments. Furthermore, the study found that both infrastructure development and employment strongly influenced each other. The implication is that infrastructure development helps in job creation where labour is utilised in maintenance, construction and operation activities. Labour contributes to infrastructure development also through aggregate demand and economic growth.

Physical infrastructure is heterogeneous and analysing the impacts of diverse infrastructure types (transport, ICT, energy, or water) is beneficial in understanding the particular infrastructure relationship with economic growth. Knowledge of the specific infrastructure and economic growth relationship will help in conceptualising appropriate policies that would have been more impactful in influencing economic growth and the required investments in infrastructure.

3.4 Variables and Methods of Model Analysis

From the preceding review, the growth rate of GDP per capita is the preferred proxy in FDI studies to represent economic growth (see Owusu-Manu *et al.*, 2019; Agbola, 2014; Bakar *et al.*, 2012; Demirhan and Masca, 2008; and Kirkpatrick *et al*., 2006). GDP growth rate is a significant explanatory variable than GDP, insinuating that profit-seeking foreign investors prefer economies that are growing to economies that are large.

In chapter two, it is revealed that the most preferred measure of FDI inflows has been net FDI inflows as a percentage of GDP. The studies where FDI inflows as a percentage of GDP was used as a proxy of FDI inflows include Nguea (2020), Gherghina *et al*. (2019), Rahman *et al.* (2019), Agbola (2014), Waikar *et al.* (2011) and Demirhan and Masca (2008). Physical infrastructure is the preferred proxy to represent infrastructure (see Gherghina *et al*., 2019; Shi *et al*., 2017; Pradhan and Bagchi, 2013; Calderon and Serven, 2014; and Estache and Garsous, 2012). Furthermore, the physical infrastructure variable appears in the FDI equation either as an aggregate or individual type (either as transport, energy, ICT or water variable). The statistical strength of the evidence on the real GDP and growth payoffs of infrastructure is underestimated by using other proxies such as public capital to represent infrastructure (Straub, 2011; Pritchett, 2000).

Pradhan *et al.* (2013) studied the long-run relationship between economic growth, FDI and transport infrastructure in India. The ARDL bounds testing approach (combining ARDL and vector error correction model as in Pesaran *et al*. (2001)) was used in the analysis. Annual time series data was used by Pradhan *et al.* (2013) where transport infrastructure was proxied by rail (length) and road (length). GDP represented economic growth. Both rail and road are analysed separately and at a group level where the composite index representing transport infrastructure is derived using PCA . The study results showed the existence of a long-run equilibrium relationship (cointegration) between the three variables. The causality test undertaken in the study showed the presence of bidirectional causality between FDI and transport infrastructure; transport infrastructure and economic growth; and FDI and economic growth.

Dependable measures of particular coefficients of variables proxying various types of infrastructure are difficult to ascertain while using linear regression method because of the close association of various infrastructure categories (Calderon and Serven, 2004). For this reason, researchers build composite indices representing infrastructure using PCA. Calderon and Serven (2004) studied the impact of infrastructure development on income distribution and economic growth where the underlying variables composite indices are given by the first principal component. The aggregate index is built from data from the sectors of telecommunication, power and transport (main telephone lines, electricity generation capacity and road network length, respectively). In the analysis, the proportion of the population with safe water access is used to measure the impact of infrastructure on income distribution.

Pradhan and Bagchi (2013) examined the impact of rail and road (transportation infrastructure) on the growth of the economy in India using the VECM. Pradhan’s (2007) study of the relationship between infrastructure development and urbanisation in India applied the PCA method to create a composite infrastructure development index. The physical infrastructure development index was prepared using variables such as telecommunication, per capita electricity consumption, total irrigated area, and transport (railways and road). The study findings show the differing direction of causality presented in three possible ways; that is, unidirectional or bidirectional or no causality between infrastructure and other variables of interest such as economic growth and FDI.

3.5 Conclusion

The literature review reveals that studies that have explored the nexus between infrastructure, FDI and economic growth are rare. This study attempts to examine the relationship between all three variables. The literature discloses that there is a contrasting relationship determined to exist between FDI, infrastructure development and economic growth, and therefore necessary to determine the relationship for Kenya. The three factors could be said to have bidirectional or unidirectional relationship among each other depending on the characteristics and conditions of the region being analysed. The short-run and long-run relationship between the variables can also be positive or negative and can have a significant or insignificant effect.

Most of the cited literature reveal positive relationships between any two of the three variables of the study. However, some cases are notable, including Shi *et al.* (2017) study that reveal a negative impact of infrastructure on economic growth; Siyal *et al.* (2016) analysis reveal infrastructure not having a significant influence on economic growth; Owolabi (2015) Granger causality test reveals no mutual correlation between economic growth and infrastructure development; Almfraji and Almsafir (2014) review of several studies show FDI effect on economic growth is positive and negative in other cases; Snieska and Simkunaite (2009) study using diverse types of infrastructure show mixed results where transport effect on economic growth was positive, while ICT and sanitation had a negative effect; and Evans and Karras (1994) reveal a negative effect of infrastructure on economic growth. The contrasting effects between FDI and infrastructure was shown in chapter two in studies that include Owusu-Manu *et al.* (2019), Asongu and Odhiambo (2019) and Nguea (2020).

The literature further reveals that similar amount of infrastructure investments have different multiplying effects depending on a country's level of economic growth. This study observes the multiplying effect behaviour (impact) of physical infrastructure on FDI and economic growth for Kenya.

The literature review shows the existence of gaps in the study of the impacts of physical infrastructure investments on economic growth and FDI. Furthermore, it is learnt that there is no agreement on the main determinants of economic growth, and an all-inclusive economic growth model covering all the identified determinants is yet to be formulated. By studying the causal relationship between the three variables, an attempt is made to establish whether infrastructure and FDI are significant determinants of economic growth in Kenya.

Annual time series secondary data has been utilised in many of the studies. The growth rate of GDP per capita has represented economic growth, and FDI net inflows as a percentage of GDP has represented FDI in many studies. Infrastructure has been proxied in most research by physical infrastructure such as roads, internet, railways, air passengers and freight, mobile phone subscribers, energy consumption, and safe water access. The literature has shown that physical infrastructure leads to more pronounced, reliable and conclusive results than monetary measures, hence adopted in this study. It is also noted that imprecise estimates will most likely result from econometrics (especially time-series) when multiple types of infrastructure assets are considered simultaneously. Therefore, synthetic infrastructure indices are encouraged to be used (Calderon and Serven, 2014). Furthermore, physical infrastructure is heterogeneous, and impacts by diverse types of infrastructure (transport, ICT, energy, or water) better captures the specific infrastructure relationship with economic growth and FDI. The specific infrastructure type used will aid in devising appropriate policies that will be more impactful in influencing economic growth and needed infrastructure investments.

The literature reviewed in chapters two and three has shown preferred methodologies and variables that are utilised to study the causality between infrastructure, FDI and economic growth. Diverse measures of infrastructure, FDI and economic growth variables and different models have been employed. Single-country research on the relationship between FDI and economic growth is recommended because of potential heterogeneity. A study for Kenya is therefore worthwhile.

From the literature review in chapter two and three, recent studies have opted to utilise the ARDL bounds cointegration testing approach to investigate the relationship among any two or all three of the variables of interest, that is, economic growth, infrastructure and FDI (see Egbetunde and Fasanya (2014), Belloumi (2014), Pradhan *et al.* (2013)). The VECM and Granger causality methods are also utilised to study short-run and long-run causality and cointegration relationships between infrastructure, FDI and economic growth (see Gherghina *et al*., 2019; Mbulawa, 2017; Shi *et al.,* 2017; Siyal *et al.,* 2016; Owolabi, 2015; Pradhan and Bagchi, 2013). The short-run and long-run causality and cointegration relationships ought to be studied to give the status and appropriateness of government policy, and specifically in relation to infrastructure spending. The ARDL approach makes it possible to study both causality and cointegration relationships concomitantly.

Owing to the preference and superiority cited in the literature review, this study uses widely preferred proxy variables and deploys the methodology considered most appropriate owing to data behaviour and country-specific intricacies.

Chapter 4 describes the research methodology employed in this study.

CHAPTER FOUR
RESEARCH METHODOLOGY

4.1 Introduction

This chapter discusses the preferred methodological framework for analysing the short and long-run relationship involving economic growth, FDI and infrastructure. Preferred variables used for the analysis are also chosen, justified and defined. The methodological framework and variables are selected in such a way that they are appropriate in answering the research questions as outlined in chapter one, as they inform the research hypotheses. In this way, the research objectives of the study are deemed achievable. The literature review in chapters one and two inform the methodology chosen.

The quantitative methodology is used in the study built on the positivist paradigm, where real and objective interpretation of data and results obtained hold sway. The sample size consists of secondary data for the period 1970-2019, and justification for its selection is presented in this chapter. Furthermore, the types and sources of data that are used for the analysis are discussed. The model is specified together with the econometric techniques (and software) used in the empirical analysis. To ensure the credibility of running the chosen models and obtaining dependable results, important requisite tests are presented. The tests include tests for optimum model lag length, unit root and diagnostic tests of time series models. The summary of the chapter contents is presented last.

4.2 Methodological Framework

4.2.1 Model Variables

The study's main objective was to examine the effect of infrastructure development on FDI in Kenya. The study further investigates the effects of FDI inflow on economic growth. The study captures the intricacies of the main variables by exploring the interrelationship between infrastructure, FDI and economic growth. From the literature review contained in the previous chapters, it is observed that economic growth is a determinant of FDI, and infrastructure is a determinant of both FDI and economic growth. FDI is also argued to impact economic growth. FDI and economic growth also impact infrastructure development.

Table 4-1 provides a summary of key models used by researchers to explain FDI.

Table 4-1: FDI Theories and Determinants

Theory	Explanatory Variables
Capital market theory	- Capital (finance)
Location-based approach to FDI theories	- Infrastructure - Local market size - Natural resources endowment - Government policy (trade openness) - Availability of labour
Institutional FDI Fitness theory	- Government - low risk (regulations to manage markets, market openness, minimal trade interventions, fewer exchange rate interventions, low corruption, the rule of law, and transparency) - Market - Educational and socio-cultural fitness (skills and labour)
Dynamic Macroeconomic FDI Theory	- Government policies, - GDP - domestic investment (infrastructure) - Real exchange rate, - Inflation rate - Interest rate - Market size, - Productivity - Openness of the economy
The Eclectic Paradigm	- human resources, - natural resources, - capital - intangible (entrepreneurial skills, management skills, information and technology, and marketing skills) - Risk (cultural, legal, political, and institutional environment)

As suggested in the previous chapter that surveys some of the available literature, it can be deduced that many variables are cited in the theoretical and empirical literature as possible determinants of FDI inflows. However, a few are consistently significant across the broad set of empirical studies. Lack of agreement among researchers on a theoretical framework that would guide FDI empirical studies leads to a lack of a generally accepted set of explanatory variables considered the ideal determinants of FDI (Moosa, 2009). Therefore, this study, whose main study variables are FDI, infrastructure and economic growth, will add control variables in the analysis. The control variables will be picked from the variables that have been used widely in previous FDI empirical analysis, as documented in the previous chapters (see Nguea, 2020; Owusu-Manu *et al.,* 2019; Bakar *et al*., 2012; Demirhan and Masca, 2008; and Kirkpatrick *et al*., 2006). Some of the control variables are also determinants of economic growth and infrastructure development. Rao (2018) argues that reduction in macroeconomic risk factors is key in unlocking bank finance for infrastructure projects. The macroeconomic risk factors are interest rates, commodity prices (inflation), unemployment rates (influenced by education levels), and exchange rates. Savings (financial development) also determine the rate of infrastructure development (Demirhan and Masca, 2008). Labour, trade openness, exchange rate and inflation are some of the determinants of the rate of economic growth (see Rahman *et al.,* 2019; Chingoiro and Mbulawa, 2016; Boldeanu and Constantinescu, 2015; and Pietak, 2014). Studies that have examined the relationship between either two or all three variables (infrastructure, FDI and economic growth) have run models that have each of the variables explained by the others (see Babajide and Lawal, 2016; and Pradhan *et al.*, 2013).

This study will use inflation, exchange rate, trade openness, financial development and labour force as the control variables. Owing to the small sample size, few control variables are used to avoid an overfit model that can cause misleading R-squared and regression coefficients and p-values. The study, therefore, utilises the variables contained mainly in the location-based approach to FDI theories and dynamic macroeconomic FDI theory. The variables are defined in the next section.

Foreign Direct Investment

The most preferred measure of FDI inflows has been net FDI inflows as a percentage of GDP. Some studies that have used this measure include Nguea (2020), Gherghina *et al*. (2019), Rahman *et al.* (2019), Agbola (2014), Waikar *et al.* (2011) and Demirhan and Masca (2008). Therefore, this study used FDI inflows as a percentage of GDP to represent FDI inflows. The effect of FDI on economic growth and infrastructure development is expected to be positive (see Owusu-Manu *et al.*, 2019; Rahman *et al.*, 2019; Serdaroğlu, 2016; Majumder, 2016).

Infrastructure

As the main objective of this study is to determine the effect of infrastructure on FDI in Kenya, physical infrastructure is chosen as the main exogenous variable. The preference for the use of physical infrastructure in studies undertaken in developing countries has gained momentum of late. Straub (2008, 2011) shows the current preference of using physical indicators to be 76% of recent studies compared with 24% that use public capital data. Studies using physical infrastructure measures are argued to have more realistic results (Calderon and Serven, 2014; Estache and Garsous, 2012). Inefficiencies in public procurement and bad governance (corruption), mostly in developing economies, have been found to catalyse non-correspondence between public capital expenditure and provision of infrastructure services (Pritchett, 2000; Straub, 2011). One may safely suggest that physical infrastructure matters for economic growth and should be factored into models.

The physical infrastructure variable appears in the FDI equation either as an aggregate or individual type (either as transport, energy, ICT or water variable). Some studies have included several types of physical infrastructure variables together as explanatory variables in a single equation of analysis. Including several types of individual infrastructure variables in one equation is discouraged because of homogeneity among the variables. This study will analyse four separate FDI equations, one each having either an aggregate infrastructure variable generated from the PCA method, transport variable, energy variable, ICT variable or water variable. The findings of the analysis will be the determination of aggregate infrastructure and individual physical infrastructure effects on FDI and economic growth. The use of diverse types of infrastructure (transport, ICT, energy, and water) in the analysis will better capture the specific infrastructure effect. The determination of the specific infrastructure effect will help in conceptualising appropriate policies that are more impactful in influencing FDI inflows and economic growth.

The proxies to be used are transport (length of paved roads), energy (electricity effective installed capacity), ICT (telephony connections) and water (government expenditure on water supplies). Length of roads and telephony connections have been used as proxies respectively for transport and energy infrastructure in Snieska and Simkunaite's (2009) study. Length of roads is also a proxy in Gherghina *et al*. (2019), Shi *et al*. (2017), Pradhan and Bagchi (2013), Pradhan *et al.* (2013), Pradhan (2007), and Calderon and Serven (2004). Rail length has also been utilised in some studies to proxy for transport infrastructure, but most transport infrastructure public investments in Kenya have been directed towards road development. Therefore, a road variable proxying transport infrastructure is preferred in this study. Electricity generation capacity proxied energy in Shi *et al*. (2017), Calderon and Serven (2004), Kirkpatrick *et al*. (2006) studies, while Nguea (2020) and Pradhan (2007) used electric power consumption. Majumder (2016) used energy use per capita - kg of Oil Equivalent to proxy energy infrastructure. It can be argued that the electricity produced equals electricity consumed in Kenya since there is insignificant power trade between Kenya and its neighbours. For example, out of 11,620.7 GWh (Gigawatt hour) available in 2019, imports consisted of 212 GWh, imports 16.2 GWh (Government of Kenya, 2020). The local generation of electricity was

11,408.6 GWh in 2019. Therefore, this study will adopt electricity generation capacity as a proxy for energy infrastructure. The number of telephone connections has been used to represent ICT by Shi *et al*. (2017), Agbola (2014), Snieska and Simkunaite (2009), and Kirkpatrick *et al*. (2006). This study will also use telephone connections to represent ICT variable in the equations of analysis.

Pradhan (2007) used the total irrigated area to represent water infrastructure, whereas Snieska and Simkunaite (2009) used resident population connected to wastewater collection and treatment. But these data are not available to cover the entire period of study (1970-2019). Therefore, the study will utilise government development expenditure on water supplies to represent water infrastructure. The use of government expenditure to represent infrastructure investment has been used successfully in several studies. Siyal *et al*. (2016) used development expenditure, and Bakar *et al.* (2012) utilised real government expenditure per real GDP to represent infrastructure investment in their studies.

The studies by Kumo (2012), Pradhan (2007) and Calderon and Serven (2004) used aggregate infrastructure variables in their studies. Pradhan (2007) and Calderon and Serven (2004) used PCA to generate the aggregate infrastructure index.

The expected effect of infrastructure on FDI inflows and economic growth is positive (see Rahman *et al.*, 2019; Pradhan *et al.*, 2017; Majumder, 2016; Kirkpatrick *et al*., 2006). Countries with more and better infrastructure will attract more FDI and attain higher economic growth. The productivity potential of investments is enhanced by good quality and well-developed infrastructure, which further stimulates FDI flows. However, the physical infrastructure proxy variables face criticism of only representing the availability but not the reliability of the infrastructure (Demirhan and Masca, 2008).

Economic Growth (Market Size)

The market size appears as an independent variable in most empirical studies examining FDI. The growth of the market size is translated to equal the growth of the economy. Moreover, the market size reflects the condition of the economy and potential demand for output, which determine whether a firm should undertake FDI. The growth rate of GDP per capita is the preferred proxy in FDI studies to represent economic growth (see Owusu-Manu *et al.*, 2019; Agbola, 2014; Bakar *et al.*, 2012; Demirhan and Masca, 2008; and Kirkpatrick *et al*., 2006). GDP growth rate is a significant explanatory variable than GDP, insinuating that profit-seeking foreign investors prefer economies that are growing to economies that are large. The growth performance of an economy is a better indicator of the potential of the market. The study expects a positive relationship between market size with FDI inflows and infrastructure development (see Bakar *et al*., 2012; Demirhan and Masca, 2008; Kirkpatrick *et al*., 2006). A fast growing economy has more opportunities for profit-making than those growing slowly (Demirhan and Masca, 2008). Economic growth increases domestic capital formation (infrastructure) in the economy (Bakar *et al.*, 2012).

Macroeconomic Stability

The literature suggests that macroeconomic stability has a significant impact on FDI inflows. The two commonly used measures of macroeconomic stability determining FDI inflows are inflation and exchange rate. The monetary policy consistency is captured by the annual change in the rate of inflation. The rate of inflation is measured by the annual percentage change of consumer price indices. The effect of inflation on FDI can either be positive or negative. FDI activities are discouraged by an inflation rate that is volatile and unpredictable, which creates uncertainty. On the contrary, FDI inflows are enhanced by a stable inflation rate showing a stable macroeconomic environment with minimal investment risk. The value of investments and profits are eaten up through inflation. Demirhan and Masca's (2008) study showed a negative effect of inflation on FDI, while in Kirkpatrick *et al*. (2006), inflation had a positive impact. The expectation of this study is that inflation has a negative effect on FDI, economic growth and infrastructure development since it eats into profits and investments. Rising inflation will cause FDI and economic growth to decrease, and vice versa. Inflation will lessen the amount of resources available to invest in infrastructure development.

The economic stability measure in an FDI equation is represented by the annual change in the official exchange rate. The effect on FDI can either be positive or negative subject to the level and volatility of the exchange rate (Kwoba and Kibati, 2016). A high exchange rate level lessens the revenues from exports, therefore, discouraging FDI. High volatility of the exchange rate hinders FDI inflows and economic growth as earnings might be affected adversely. A stable rate of exchange creates a positive environment for FDI and economic growth. A low and stable exchange rate creates a conducive environment for FDI where the increase in revenues from local trade and exports improve profits. Muthoga (2003) found a negative effect of the exchange rate on FDI in Kenya. Babajide and Lawal (2016) found a positive but insignificant impact of the exchange rate on FDI for Nigeria. A negative effect is expected from the exchange rate since a high exchange rate level lowers the revenues from exports and, in the process, discourages FDI and hinders economic growth. The reduction in macroeconomic risk factors (e.g., inflation and exchange rates) is key in unlocking bank finance for infrastructure projects (Rao, 2018). Therefore, high inflation and exchange rates will discourage infrastructure development. This study uses the annual average Kenya shilling exchange rate against the United States Dollar (Ksh/USD).

Trade Openness

Trade openness is extensively used in FDI empirical research and is usually measured as the ratio of imports and exports to GDP. It is mostly found to be positively related to FDIs because it reflects the commitment of the economy to freer movement of goods and services in the international market (see Demirhan and Masca, 2008 and Bakar *et al*., 2012). Another explanation is that market seeking investments in an environment of trade restrictions leads to a positive impact on FDIs. The "tariff jumping" hypothesis explains enhanced FDI inflows emanating from trade restrictions as firms seeking to serve local markets opt to establish subsidiaries in the foreign country because of the difficulty of exporting their products to that country. Since trade openness ought to mean a liberal trade regime, trade protection that provides domestic and foreign firms with protection from international competition leads to a negative effect on FDI, particularly on the locational decision. Studies that have found a negative effect of trade openness on FDI inflows include those of Owusu-Manu *et al.* (2019) and Kirkpatrick *et al*. (2006).

The effect of trade on economic growth and infrastructure development is expected to be positive. Trade is indistinguishably associated with development financing and is an instrument of economic growth (Kumo, 2012).

Financial Development

The financial development level of a country determines the rate and pattern of economic development. Large-scale private investments financing in the country is made easy when the domestic financial and capital markets are well developed. The well-developed financial markets encourage FDI inflows and enhance economic growth (Mbulawa, 2017; Aregbeshola, 2016; Almfraji and Almsafir, 2014).

More FDI inflows are attracted to the economies where the financial infrastructure is in the early stages of development (Kirkpatrick *et al*., 2006). Kirkpatrick *et al*., (2006) used domestic credit divided by private sector to GDP ratio to represent financial development in their study. The effect of financial development is expected to be positive on FDI, economic growth and infrastructure development. The more Kenya develops its financial sector, the more likely the realisation of FDI inflows and economic development. The development of the financial sector and realisation of more savings is expected to provide finances to develop infrastructure. Domestic credit to the private sector (% of GDP) is used to represent financial development.

Labour Force (Human Resource)

Another explanatory variable widely used as an exogenous variable in FDI empirical studies is the labour force. Several measures are used to measure the labour force, including educational achievement, total education expenditure, secondary school enrolment rate, skills level, and wage rates. The secondary school enrolment rate is adopted in this study to represent the labour force (human capital) partly because of the availability of data. Kirkpatrick *et al*. (2006) used secondary school enrolment rates in their studies. Recent literature has encouraged the use of a skilled and educated labour force owing to the advanced technologies used in modern production processes. In older studies, unskilled labour that was cheap was regarded as attracting FDI flows that was composed of labour-intensive production mostly meant for the export market. Owing to the two facets of the labour force, the analysis of most FDI equations produce results that have a wrong sign or that are statistically insignificant (Kirkpatrick *et al*., 2006). Because of the use of secondary school enrolment rate to represent the labour force, the anticipated effect on FDI is positive. Labour is a factor of production and therefore is anticipated to have a positive effect on economic growth. Moreover, labour is also an important input in infrastructure development with a positive effect (see Kumo, 2012).

Based on the above study variables, augmented by the control variables, the models of analysis are:

$$FDI = f(INFR, GDP, C, D) \quad [1]$$

$$GDP = f(FDI, INFR, C, D) \quad [2]$$[3]

$$INFR = f(FDI, GDP, C, D) \quad [3]$$[4]

Where,

FDI	=	Foreign Direct Investment
INFR	=	Infrastructure
GDP	=	economic growth
C	=	Control variables - trade openness (OPN); inflation rate (INFL); exchange rate (EXC); financial development (CRD); and labour force (LAB)
D	=	dummy variables to represent possible equation structural breaks.

Table 4-2: Anticipated Signs of the Study Variables

	Dependent Variable	**Determinant**	**A priori expectation**
1	Foreign Direct Investment	Infrastructure	Positive
		Economic Growth	Positive
		Trade openness	Positive
		Inflation rate	Negative
		Exchange rate	Negative
		Financial development	Positive
		Labour resources	Positive
2	Economic Growth	Infrastructure	Positive
		Foreign Direct Investment	Positive
		Trade openness	Positive
		Inflation rate	Negative
		Exchange rate	Negative
		Financial development	Positive
		Labour resources	Positive
3	Infrastructure	Foreign Direct Investment	Positive
		Economic Growth	Positive
		Trade openness	Positive
		Inflation rate	Negative
		Exchange rate	Negative
		Financial development	Positive
		Labour resources	Positive

[3] See Rahman *et al.* (2019); Shi *et al.* (2017); Pradhan and Bagchi (2013)
[4] See Pradhan *et al.* (2013)

Annual time series secondary data has been used in many of the studies referred to in the literature review.

4.2.2 Time Series and Models

This study utilises annual time series data taken for the period from 1970 to 2019. Care is taken in the calibration of the models and the estimation procedure. According to Aregbeshola (2018, 2014), the wrong specification of the model or method of analysing time-series data provides biased and unreliable estimates. This observation was also supported in the work of Shrestha and Bhatta (2018). As a step to avoid misspecification, stepwise regression is also followed with unit root tests. This is done to know the stationarity of the variables being studied. More importantly, the approach is key in the selection of appropriate regression methods to analyse time-series data. Aregbeshola (2019) suggests that some methods are appropriate for analysing stationary time series, while others are statistically fit to analyse non-stationary series. In the simplest case, Aregbeshola (2017a) argues that OLS or VAR models provide estimates that are unbiased when the variables under study are stationary. Neither the OLS nor the VAR is appropriate to analyse the relationship between non-stationary variables or those of mixed nature where some of the variables are non-stationary while others are stationary. If OLS and VAR are used in non-stationary case, spurious results are produced where a misleading significant relationship may be shown to exist between variables when they are un-correlated.

Another technique is to adopt one of the various methods, including filtering, de-trending or differencing to make non-stationary variables stationary. However, the long-run relationships and variables under study might disappear during the conversion of non-stationary variables to stationary.

Several methods have been developed to analyse the relationships between non-stationary variables. These methods include the Johansen cointegration test (Johansen and Juselius, 1990;

Johansen, 1988), cointegration test (Engle and Granger, 1987), Granger causality test (Granger, 1969) and ARDL model. According to Shrestha and Bhatta (2018), the ARDL method is considered superior to all the others as it is appropriate for time series that are both non-stationary as well as those having mixed integration order.

From the literature review, recent studies have opted to utilise the ARDL bounds cointegration test approach to investigate the relationship among any two or all three of the variables of interest, that is, infrastructure, inflow of FDI and economic growth (see Egbetunde and Fasanya, 2014, Belloumi 2014, Pradhan *et al.*, 2013). The VECM and Granger causality methods are also utilised to study short-run and long-run causality and cointegration relationships between infrastructure, FDI and economic growth (see Gherghina *et al*., 2019; Mbulawa, 2017; Shi *et al.*, 2017; Siyal *et al.* (2016), Owolabi (2015), Pradhan and Bagchi (2013)). The short-run and long-run causality and cointegration relationships should be studied to give the status and appropriateness of government policy, specifically in relation to infrastructure spending. The ARDL approach makes it possible to study both causality and cointegration relationships concomitantly.

Sahoo and Das (2012) study utilised the ARDL model and bounds cointegration test which is given in Pesaran *et al.* (2001) and noted that it is superior to traditional cointegration methods of Johansen and Juselius (1990), and Engel and Granger (1987). The VECM formulation estimates are consistent and asymptotically normally distributed regardless of if the underlying series are I(0) or I(1)[5]. The ARDL bound cointegration technique and the VECM are reliable for a small sample. Endogeneity is not problematic unless the errors in the ARDL model are serially correlated.

[5] I(1) is variable whose first difference is stationary. I(0) denote a stationary variable.

Khandelwal (2015) acknowledges that the ARDL approach's main advantage is that it is usable even in instances where various variables have different orders of integration. In cases of different orders of integration, traditional cointegration techniques like Johansen (1988), and Engle and Granger (1987) are not usable. ARDL is also used to estimate cointegration where there is a very small number of sample cases.

The ARDL cointegration test (popularly known as the bounds test) is a simple technique compared to other multi-variate cointegration methods where the cointegration relationship is estimated by OLS (Egbetunde and Fasanya, 2014). Adoption of the bound testing approach may not require the unit root pre-test before running the model meaning the regressors can be I(0), I(1) or a mixture of both integrations. By using the ARDL bounds test, it is possible to undertake simultaneous estimation of the short-run and long-run parameters of the models.

Shi *et al.* (2017) contend that the VECM is used to address empirical shortcomings arising owing to the nature of data and the model when investigating infrastructure investment and economic growth. The VECM can clearly specify the relationship between economic growth and infrastructure development both in the long-run and short-run, considering the confirmed cointegration of the unit root variables. The estimates of long-run parameters are super-consistent, irrespective of the variance structure of the model even when weak exogeneity is presumed. By including extra lagged differenced terms, the VECM flexibility permits probable endogeneity among short-run lags and the unobserved factors intended to be addressed.

The ARDL bounds testing technique combines both the ARDL model analysis and the Granger causality test. The relationship between the variables of the study, which may be unidirectional, bidirectional, or no causation, is revealed when the Granger causality test is undertaken. Knowledge of the direction of causality is the foundation for effective policy formulation. The Granger causality test helps in deciding the direction of causation among variables by determining the variable that is the cause and the variable that is the effect. In the ARDL bounds testing technique, the Granger causality test serves as a complement and validity test of the existence of cointegration relation and further reveals the direction of the causation if it exists (Shrestha and Bhatta, 2018).

More importantly, the ARDL bounds testing approach (Pesaran *et al.*, 2001), which is preferred and adopted in this study, is performed in two steps, where Step 1 comprises testing for cointegration (testing whether the long-run equilibrium relationships exists in the three models), while Step 2 involves specifying the VECM when cointegration has been determined so as to estimate the long-run dynamics and short-run estimations, followed by determination of causality via Granger causality process. If cointegration is not ascertained, a short-run ARDL model is specified and analysed to determine the short-run estimations. The Granger causality test (Granger, 1969) is undertaken to establish the validity of the study hypotheses. This two-stage approach is superior to other available methods of analysing causal relationships.

The ARDL bounds testing approach is illustrated next:

(a) The ARDL error correction model

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{p} \beta_i \Delta y_{t-1} + \sum_{i=0}^{q} \delta_i \Delta x_{t-1} + \sum_{i=0}^{r} \varepsilon_i \Delta z_{t-1} + \lambda_1 y_{t-1} + \lambda_2 x_{t-1} + \lambda_3 z_{t-1}$$
$$+ \sum_{r=0}^{w} \pi_r C_{t,r} + \sum_{e=0}^{v} \in_e D_{t,e} + \mu_t \ldots\ldots\ldots [4]$$

Where:

$\beta, \delta, \varepsilon$ = Short-run dynamics; and $\lambda_1, \lambda_2, \lambda_3$ = Long-run relationship

$\lambda_1 + \lambda_2 + \lambda_3 = 0 -$ Null Hypothesis of equation implying lack of long-run relationship. $C_{t,r}$ are control variables, and $D_{t,e}$ are dummy variables to represent possible equation structural breaks.

(b) Causality test

Causal relationships between two variables are observed using the Granger causality test (Granger, 1969). The test examines whether current changes in variable Y are because of past changes in other variables, along with past changes in Y itself (see Siyal *et al*., 2016). The variables in the model are interchanged to see the causality in other directions. The pairwise Granger causality model for Y and X variables is illustrated next:

$$\Delta Y_t = \sum_{i=1}^{n} \alpha_i \Delta Y_{t-i} + \sum_{j=1}^{n} \beta_j \Delta X_{t-j} + \mu_{1t} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.. [5]$$

$$\Delta X_t = \sum_{i=1}^{n} \lambda_i \Delta X_{t-i} + \sum_{j=1}^{n} \delta_j \Delta Y_{t-j} + \mu_{2t} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.. [6]$$

Above equations [5] show that Y is being tested for relation to its past values and of X. Equation [6] equally shows that X is connected to its previous values and those of Y.

The null hypotheses in equations [5] and [6] are $\beta_j = 0$ (X does not Granger cause Y) and $\delta_j = 0$ (Y does not Granger cause X). Results of the F-statistics[6] determine rejection or acceptance of the null hypothesis.

The causality test results are translated into three possible scenarios of relationship – bidirectional, unidirectional or no causality. Cointegration of two variables X and Y exist if (i) X and Y impact on another (bidirectional relationship), (ii) X affects Y, and (iii) Y affects X. (i) and (ii) shows the existence of the unidirectional relationship. If neither of the two variables

[6] the overall F-test is not statistically significant when none of the independent variables is statistically significant. Econometric software is used to calculate the F-statistic which is interpreted accordingly.

affects the other, there is no causality between them and no integration.

4.2.3 Optimum Lag Length of the Models

Researchers impose zero coefficients on those variables whose *'t'* statistic is low in the model to shorten the size of the model. The Akaike Information Criterion (AIC) is used as a guide to parsimonious reductions, where effort is made to simplify the over-parameterized model into a more parsimonious characterisation of the data (Akaike, 1973). However, no criterion of determining optimal lag length is considered superior to the other one (Brooks, 2014). The AIC is chosen because it is considered better for small samples. The following equation defines the AIC criteria:

$$\text{AIC} = -2(\text{log-likelihood}) + 2K \qquad [7]$$

Where K = sum of model parameters plus the intercept, log-likelihood = model fit measure. The higher the log-likelihood number, the better the fit.

The AIC criteria is utilised in ascertaining the lag length for the regression models and Granger causality tests. In the IHS Global (2017) Econometric Views (EViews[7]) software which is utilised in the analysis, the optimal lag lengths are determined by estimating standard VAR or unrestricted VAR where the three main variables under investigation are entered as endogenous variables with constant as the exogenous variable. The AIC is the preferred criterion in the selection of the optimal lag, where the lag with the lowest AIC value is selected. A reduction in the absolute value of AIC is a sign of model parsimony. The lowest AIC value is chosen, where the lower the AIC value, the better the model (rule-of-thumb).

The determined optimal lag length is also used in Granger causality testing. It is worthwhile to

[7] EViews is a Windows statistical software used mainly to analyse time-series econometric models. See https://www.eviews.com/home.html

note that the study has a small sample size (1970-2019). The findings of the Granger causality test are dependent on the lag length chosen in small to moderately sized samples (Bruns and Stern, 2015). Aregbeshola (2014) argues for the restriction of lag lengths when a study has a small sample size. To get the total sum of lags to use in the Granger causality test analysis, the maximum order of integration is added to the lags picked through the VAR technique (see Granger, 1969).

A large number of lags in a model may generate residuals that are close to the white noise process [8] but might not be parsimonious. In contrast, fewer lags can lead to parsimonious models, although they may generate residuals that are not closer to a white noise process (Coban and Yussif, 2019). The estimation of the ARDL model and VECM are very sensitive to lag length (Pradhan *et al.*, 2013).

4.2.4 Diagnostic Tests of the Time Series Model

4.2.4.1 Unit Root Test - Stationarity Test

The unit root tests often utilised to test the stationarity of time series data, *inter alia*, include Kwiatkowski, Phillips, Schmidt and Shin (Kwiatkowski *et al.*, 1992), Phillips Perron (Phillips and Perron, 1988), and Augmented Dickey-Fuller (Dickey and Fuller, 1979).

(a) Augmented Dickey-Fuller (ADF) Test

The ADF model tests the unit root as follows:

$$\Delta y_t = \partial y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta y_{t-i} + e_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{[8]}$$

[8] A white noise implies a random process of arbitrary and uncorrelated variables that have zero mean and a variance that is finite.

$$\Delta y_t = \varphi + \partial y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta y_{t-i} + e_t \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots . [9]$$

$$\Delta y_t = \varphi + \partial y_{t-1} + \gamma t + \sum_{i=1}^{k} \beta_i \Delta y_{t-i} + e_t \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots . \ldots \ldots \ldots \ldots . \ldots \ldots . [10]$$

where, $\partial = \varphi - 1$, where $\varphi =$ coefficient of y_{t-1};

and $\Delta y_t =$ first difference of $y_t, i.e. y_t - y_{t-1}$

When the data series does not have a drift or a trend, equation [8] is used; if there is drift and no trend, equation [9] is utilised; and if the series has both drift and trend, equation [10] applies. The time-series data are graphed, and their pattern observed to determine which of the above models to use.

The null hypothesis is $\partial = 0$. The alternative hypothesis is $\partial < 0$. The series is stationary if the null hypothesis is rejected and non-stationary if the null hypothesis is not rejected.

(b) Phillips-Perron (PP) Test

The PP model test is as follows:

$$\Delta y_t = \vartheta y_{t-1} + \sigma_i D_{t-1} + e_t \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots .. \ldots \ldots \ldots [11]$$

where e_t is I(0) with a mean of zero and D_{t-1} is a deterministic trend component. The null hypothesis is $\vartheta = 0$. The alternative hypothesis is $\vartheta < 0$. Non-rejection of the null hypothesis means that the time series are non-stationary, while stationarity of the series exists when the null hypothesis is rejected.

The two tests (ADF and PP) are sometimes used jointly to test unit root so that any deficiencies existing in either of the two methods are minimised. A notable deficiency of the ADF test is the reduced power of testing brought about by the loss of degrees of freedom arising from inclusion in the testing equation of extra differenced terms. Hence, the PP test is afflicted with serious size distortions (with the real size much greater than the nominal size) with largely negative autocorrelations of the error term (Campbell and Perron, 1991).

(c) Kwiatkowski, Phillips, Schmidt and Shin (KPSS) Test

In most economics time series, the commonly used unit root tests fail to reject the null hypothesis of a unit root (Kwiatkowski *et al.*, 1992). KPSS tests the null hypothesis where the series is observed to be stationary around a deterministic trend. Unlike the ADF and PP tests, KPSS's null hypothesis is that the series is stationary, and the alternative hypothesis in the series is non-stationary.

KPSS is expressed as follows:

$$Y_t = \beta_t + (r_t + \partial) + e_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [12]$$

where, $r_t = r_{t-1} + \mu_t$ is a random walk, $r_0 = \partial$ serves as the intercept. μ_t are independent and identically distributed (IID) – N(0, σ_μ^2). Null hypothesis = Y_t is a trend (or level) stationary or $\sigma_\mu^2 = 0$ (the random walk has zero variance). Alternative hypothesis is Y_t is a unit root process. The Lagrange Multiplier (LM)[9] test statistics derives the critical values of the KPSS test.

4.2.4.2 Goodness of fit

The goodness of fit is commonly tested using R^2. R^2 is the coefficient of determination and is pronounced as "R squared". R^2 shows a correlation in the bivariate case where a value close to 0 is poor while one nearer 1 (one) is preferred. The problem with R^2 is that the value increases with additional variables introduced in the regression regardless of improved predictability. For multivariate regression, adjusted R^2 is preferred where any increase of goodness of fit observed

[9] LM tests hypothesis around parameters in a likelihood framework. The test rejects the null in favour of the alternative hypothesis when *LM* exceeds a critical value in its asymptotic distribution.

is related to added variable improving prediction power of the regression.

4.2.4.3 Structural Stability Test

The long-run model stability test is performed via the CUSUM (cumulative sum control chart) test and the CUSUM of Squares (CUSUMSQ) test (see Kingori, 2007).

(a) CUSUM Test

The CUSUM test is founded on the recursive residuals cumulative sum. The cumulative sum is plotted jointly with the 5 per cent critical lines where parameter instability is found if the cumulative sum runs past the area between the two 5 per cent bound critical lines.

(b) CUSUM of squares Test

Similar to the CUSUM test, movement of the cumulative sum of squares plots beyond the confines of the 5 per cent critical lines implies parameter or variance instability.

4.2.4.4 Residual Diagnostic Tests

Residual diagnostic tests on the model analysis results include testing existence of serial correlation, normality and heteroskedasticity. The test statistics are the Breusch-Godfrey Serial Correlation LM test (serial correlation), Jarque-Bera statistic (normality), and Breusch-Pagan-Godfrey test (heteroskedasticity). The model specification error (functional form) test is carried out through the Ramsey Regression Equation Specification Error Test (RESET) test.

The normality of data being analysed is important for other parametric tests. Non-normality of the residuals may lead to problems of deriving statistical inference from the coefficient estimates (Brooks, 2014). The null and alternative hypotheses for normality tests are specified as:

H_0: Residuals are normally distributed.

H_1: Residuals are non-normally distributed.

The test for serial correlation looks at whether the lags of the residuals are correlated. Serial correlation affects the efficiency of the regression estimators rather than their unbiasedness. The associated inefficiency means that the estimators are not best linear unbiased estimator (BLUE) and implies a likelihood of making wrong inferences even if the independent variables determine the variations in the regressand (Brooks 2014). The test hypotheses are:

H_0: Residuals do not have serial correlation.

H_1: Residuals have serial correlation.

The test for heteroscedasticity checks whether there is a constant variance in the residuals. It is presumed that the residuals are homoscedastic (variance is constant) in the ARDL model. The presence of heteroscedasticity in the residuals means the coefficient estimates are not BLUE, and wrong inferences may be made as in the serial correlation case. The null and alternative hypotheses are stated as follows:

H_0: Residuals are homoscedastic (constant variance).

H_1: Residuals are heteroscedastic (non-constant variance).

The test of whether non-linear combinations of the fitted values can describe the explanatory variable is done using the Ramsey RESET test for functional form. The model is mis-specified if the explanatory variable is described by non-linear combinations of the predicted values. When there is mis-specification, the model requires adjustment. The null and alternative hypotheses are:

H_0: No specification error.

H_1: There is a specification error.

The above tests produce Chi-square asymptotic statistic or finite F-distribution (or both) output and their respective p-values (probability numbers). If the null hypothesis is true, the *p*-value indicates the probability of getting a test statistic whose absolute value is larger or equivalent to the one of the sample statistic. Accordingly, low *p*-values indicate the existence of the anomaly, and the null hypothesis is accordingly rejected. For instance, when the *p*-value is more than 0.05, the null hypothesis is rejected at the 5 per cent level, while if the *p*-value is less than 0.01, then the null hypothesis is not rejected at the 1 per cent level.

4.3 Definition of Variables, Measurement and Sources of Data

The time series secondary data that is employed in this study is aggregated (annual), spanning the period 1970-2019. The dataset is mostly sourced from the Economic Surveys and the Statistical Abstracts publications of the Kenya National Bureau of Statistics (Government of Kenya, 1970-2020) and the World Development Indicators of the World Bank (The World Bank, 2021).

The 1970-2019 sample period is considered the most significant to undertake this study for Kenya. The study is carried out during this period because of the availability of data. It is also during this period that the government expenditure on infrastructure started to be noticed. However, it is noted that huge infrastructure investments started around 2002 after a change of government that led to a change in policies and increased investment in infrastructure rehabilitation and development (Government of Kenya, 1970-2020). A test for the presence of a structural break in 2002 will therefore be undertaken during the model regression analysis.

(i) Foreign Direct Investment (FDI)

The World Bank (2021) in the World Development Indicators defines FDI as the flows of direct investment equity to the reporting economy. The FDI figure is obtained by adding together equity capital, reinvestment of earnings and other types of capital. Direct investment is a form of investment across the border where an individual from one country has substantial influence in the management of a firm in found overseas. The presence of a direct investment link is determined by the possession of 10 per cent or more of the ordinary shares of voting stock.

The annual time series data of FDI net inflows (BoP) as a percentage of GDP is utilised and was sourced from World Development Indicators (The World Bank, 2020). The FDI net inflows (new investment inflows less disinvestment) from foreign investors is divided by GDP.

$$FDI\ net\ inflows\ as\ \%\ of\ GDP = \frac{FDI\ net\ inflows\ (BoP)}{Gross\ Domestic\ Product} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [13]$$

(ii) Infrastructure (INFR)

Palei (2015) argues that researchers opt for physical proxies of public infrastructure instead of the cost parameters in most scientific works. This is to overcome difficulties that may be experienced while estimating the infrastructure. Agénor and Moreno-Dodson (2006) indicate that studies on infrastructure and growth broadly define infrastructure to include water supply and sanitation, energy, transport and ICT. Transport, water, ICT, and energy sector data represent the infrastructure variable.

In the study, infrastructure is used differently in two ways: (1) at the particular sector level, transport infrastructure (TRAI), energy infrastructure (ENEI), ICT infrastructure (ICTI) and water infrastructure (WATI) are treated individually, and (2) at the group level using a composite index, where all the infrastructure is linked contemporaneously. As in Pradhan (2007), the PCA technique is utilised in deriving the composite index of total infrastructure (INFR).

A composite index of infrastructure is derived from individual sector indicators from ICT, transport, energy and water, using the PCA methodology. As shown in Pradhan (2007), the PCA methodology is a unique case of factor analysis that constructs a new group of variables (Y_i)

named principal components, using a series of variables X_i's (i = 1,2,…,n). Y_i are a linear combination of the Xs. This representation is presented in the next equation:

$$Y_i = \sum_{i=1}^{m} \sum_{j=1}^{n} \emptyset_{ij} X_{ij} \dots\dots \quad [14]$$

Where $\emptyset_{ij}$ are principal component loadings, which are picked such that:

(a) The constructed principal components are not correlated.

(b) The first principal component (Y_1) takes the maximum possible share of all variation in the set X's. The next principal component (Y_2) takes a maximum of outstanding variation from the remains of the variation accounted for by Y_1, and this continues such that Y_m absorbs minimum variation. The principal components account for variations in descending order.

The above equation uses the original variables. The Statistical Package for the Social Sciences (SPSS) [10] is utilised in doing the PCA. In the PCA, a set of *m* components (factors) accounting for most of the variance in the *y* variables are extracted from a set of *y* variables. Each component is measured as a weighted sum of the *y* variables. The i^{th} factor is described as follows:

$$F_i = W_{i1}X_1 + W_{i2}X_2 + \cdots + W_{iy}X_y \dots\dots \quad [15]$$

The indicators that are utilised in the building of the infrastructure index are transport (length of paved roads), energy (Electricity installed capacity - MW), ICT (telephony connections – number of mobile and fixed telephone connections) and water (development expenditure on government water supply). Lack of data for the entire period of study (1970-2019) of physical

[10] https://www.ibm.com/products/spss-statistics

measure of water leads to the use of the expenditure variable. The sector proxies are described next:

a) Transport: Proxied by the length (kilometres) of paved roads. These are roads whose surface has been improved by applying bitumen on top of the improved base and distinguishable from gravel/earth roads.

b) ICT: Represented by telephony connections (all telephony subscriptions that offer voice communications) in the country, including mobile cellular and fixed telephone connections. Mobile telephone use cellular technology to give access to the public switched telephone network (PSTN), and subscriptions are to the public mobile telephone service. Fixed telephone subscriptions refer to the total active number of fixed public payphones and analogue fixed telephone lines, plus subscriptions to voice-over-IP (VoIP), fixed wireless local loop (WLL) and integrated services digital network (ISDN) voice-channel equivalents.

c) Energy: Represented by electricity installed generation capacity in megawatt (MW) predominantly sourced from hydro, fossil fuels (thermal), geothermal, biogas generation and wind power sources. Hydropower is the largest contributor with 52 per cent, followed by fossil fuels at 32.5 per cent.

d) Water: Represented by expenditure by the national government on the development of water supplies and related services. The expenditure is by the national government on water development, rural water supplies, national water conservation (water conservation, dam and boreholes construction), pipeline and irrigation development. The real variable for water development expenditure (WATI) is obtained as follows:

$$WATI = \frac{Development\ expenditure\ on\ water\ supplies}{Kenya\ consumer\ price\ index\ (2010\ =\ 100)^{11}} \dots \dots \dots \dots \dots \dots \dots \dots \dots [16]$$

The above data of paved roads representing transport, development expenditure on water supply representing water and energy (electricity installed generation capacity) is obtained from the Statistical Abstracts and Economic Surveys publications of the Kenya National Bureau of Statistics (Government of Kenya, 1970-2020). Data for ICT (telephony connections) is sourced from both the Economic Surveys (Government of Kenya, 1970-2020) and the World Development Indicators (The World Bank, 2021).

(iii) Economic Growth (GDP)

GDP is the sum of all resident producers' gross value added (GVA) and adding any product taxes while subtracting subsidies that are not part of the value of the products in the economy. The deductions for depreciation of fabricated assets or the natural resources degradation and depletion are not factored in the calculation. The growth rate of GDP per capita is utilised in this study to represent economic growth. Furthermore, the GDP per capita is GDP divided by the number of persons in the economy. The growth rate of GDP per capita is calculated as follows:

$$\text{Growth rate of GDP per capita} = \frac{(\text{GDP per capital})_{t} - (\text{GDP per capital})_{t-1}}{(\text{GDP per capital})_{t-1}} \text{ X } 100 \dots\dots\dots [17]$$

The GDP per capita data is obtained from the World Development Indicators where it is provided in constant 2010 U.S. dollars (The World Bank, 2021).

[11] Consumer price index (2010 = 100) is generally calculated using the Laspeyres formula. It shows cost changes experienced by the average consumer in purchasing a basket of goods and services. The cost of the basket may remain constant or change at specific intervals, like annually. The is generally used. The data are averages of the particular period stated (The World Bank, 2021).

(iv) Inflation

The inflation rate is a macroeconomic policy variable included in the analysis as one of the control variables. Inflation, as measured by the consumer price index (2010 = 100), is the yearly percentage change in the expenses incurred in acquiring a group of goods and services by the average consumer. The Laspeyres[12] formula is generally used.

The inflation rate data is gotten from the World Development Indicators (The World Bank, 2021) and Economic Surveys (Government of Kenya, 1970-2020).

(v) Exchange Rate

Another control variable included in the study is the official exchange rate (Kenya shilling relative to the U.S. dollar - KSH/USD). The market determines Kenya shilling's exchange rate with other currencies through forces of demand and supply. The monthly average rates assist in the calculation of the annual average used in this study.

The exchange rate (KSH/USD) data originated from the World Development Indicators (The World Bank, 2021).

(vi) Trade Openness

Trade openness is measured as the ratio of the total quantity of imports and exports to GDP. The value of all commodities and other market services delivered to Kenya from the rest of the world is referred to as imports. The value of merchandise, freight, travel, insurance, transportation, license fees, and royalties compose of the imports. Other services included in the measurement of imports are communication, financial, information, personal, construction

[12] The Laspeyres Index is computed by dividing the price of a basket of goods at prevailing costs by the price of the same basket of goods at base period costs, then multiplying the result by 100. As a result, the base period index number is 100 always.

business, and government services. The import measurement excludes investment income (factor services) and employees compensation, and transfer payments (The World Bank, 2021).

The value of all goods and other market services gotten from Kenya to the rest of the world is referred to as exports. Merchandise value, insurance, freight, travel, transportation, license fees and royalties, and other services are among them. Communication, financial, business, information, personal, construction, and government services are also the other services included. Employees compensation, investment income (factor services), and transfer payments are not included in the calculation of exports (The World Bank, 2021).

Trade openness is calculated as follows:

$$Trade\ Openness = \frac{Exports + Imports}{Gross\ Domestic\ Product} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots [18]$$

The import, export and GDP data are in constant 2010 U.S. dollars and are gotten from the World Development Indicators (The World Bank, 2021).

(vii) Financial Development

Domestic credit to the private sector (% of GDP) represents financial development in this study. In addition, domestic credit to the private sector means financial resources provided by financial organizations to the private sector (The World Bank, 2021). Loans, non-equity securities purchases, trade credits, and other repayable accounts receivables are among the financial resources. The financial organizations include deposit money banks, monetary authorities, pension funds, and money lenders. Other financial organizations are insurance corporations, finance and leasing companies, and foreign exchange companies. The domestic credit to the private sector (% of GDP) data is obtained from World Development Indicators (The World Bank, 2021) provided the .

(viii) Labour Force (Human Resource)

The number of students enrolled in secondary school enrolment per year is the proxy for the labour force in this study. Secondary education is the final stage of basic education that originated at the primary level. By providing more subject or skill-oriented instruction from more specialized teachers, the secondary education aims to lay the foundations for lifelong learning and human growth.

The secondary school enrolment annual data was obtained from the Economic Surveys (Government of Kenya, 1970-2020).

4.4 Study Hypotheses

The main research objective was to study the effect of infrastructure on FDI and its relation to economic growth in Kenya. The research generally investigated the relationship between infrastructure development, FDI inflows and economic growth in Kenya. As revealed by the literature review in the previous chapter, infrastructure and FDI are important components in determining economic growth. As shown in the literature review, infrastructure development helps to attract FDI and supports economic growth. But also, infrastructure investment is supported by FDI and higher economic growth (see Pradhan *et al*., 2013; Pradhan and Bagchi, 2013).

The six study hypotheses derived from the research questions are:

- H1: Infrastructure Granger causes FDI.
- H2: Infrastructure Granger causes economic growth.
- H3: FDI Granger causes infrastructure development.
- H4: FDI Granger causes economic growth.
- H5: Economic growth Granger causes FDI.
- H6: Economic growth Granger causes infrastructure development.

4.5 Model Specification

4.5.1 ARDL, VECM and Granger Causality

The ARDL bounds cointegration technique (Pesaran *et al.*, 2001 and Pesaran *et al.*, 2000), the VECM and Granger causality methods are used to test the study hypotheses and ascertain the causality direction existing between infrastructure, economic growth and FDI. The choice of ARDL bounds technique is based on the variation in the order of integration of the study's variables, composed of both I(1) and I(0) (integrated of order one and order zero) – see section 5.2.5 on unit root tests and choice of study analysis approach.

The ARDL bounds cointegration test is valid only under the assumption of one variable being endogenous and the independent variables being exogenous (Pesaran *et al.,* 2001). However, the performance of the ARDL test is not adversely affected by the violation of the exogeneity assumption (Sam *et al.*, 2019).

Before proceeding to the cointegration test, the unit root tests are undertaken to check for the integration order of the data series. According to Pesaran *et al.* (2001), the ARDL bounds testing approach can be used in the absence of knowledge of the order of integration of a data series, even when series are composed of orders I(1) and I(0). However, it is unsuitable for a series of order I(2) or higher.

The tests for the six hypotheses are performed using the ARDL cointegration test, VECM and the Granger causality method. The ARDL modelling approach and VECM are applied to check if any long-run relationships exist among the variables. Then Granger causality test is applied to find out the causality direction. That is, to test the six hypotheses – whether infrastructure Granger causes FDI, infrastructure Granger causes economic growth, economic growth Granger causes infrastructure development, economic growth Granger causes FDI, FDI Granger causes infrastructure development, and FDI Granger causes economic growth. The diagnostic tests are applied appropriately to check model robustness.

4.5.1.1 Cointegration Test

The ARDL model is specified as follows:

$$\Delta Y_t = a_0 + \sum_{l=1}^{q} \partial_l \Delta Y_{t-l} + \sum_{m=0}^{r} \partial_{1m} \Delta X_{1,t-m} + \sum_{n=0}^{s} \partial_{2n} \Delta X_{2,t-n} + \psi^1 Y_{t-1} + \psi^2 X_{1,t-1} + \psi^3 X_{2,t-1} + \sum_{r=0}^{w} \pi_r C_{t,r} + \sum_{e=0}^{v} \in_e D_{t,e} + \mu_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots [19]$$

Where:

Y	=	dependent variable
X	=	exogenous variables
μ_t	=	white noise
∂	=	short-run dynamic coefficient
ψ	=	the underlying ARDL model long-run multiplier
C	=	control variables
D	=	dummy variable
Δ	=	change

In this study, the next ARDL equations are used to test Cointegration between economic growth, FDI and infrastructure as done in previous studies (see Pradhan *et al*., 2013):

$$\Delta LNFDI_t = a_{0FDI} + a_1 t + \sum_{l=1}^{q} \partial_{lFDI} \Delta LNFDI_{t-l} + \sum_{m=0}^{r} \partial_{mFDI} \Delta LNGDP_{t-m} + \sum_{n=0}^{s} \partial_{nFDI} \Delta LNINFR_{t-n}$$
$$+ \psi_{FDI}^1 LNFDI_{t-1} + \psi_{FDI}^2 LNGDP_{t-1} + \psi_{FDI}^3 LNINFR_{t-1} + \sum_{r=0}^{w} \pi_r C_{t,r}$$
$$+ \sum_{e=0}^{v} \in_e D_{t,e} + \mu_{3t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [20]$$

$$\Delta LNINFR_t = a_{0INFR} + a_1 t + \sum_{l=1}^{q} \partial_{lINFR} \Delta LNINFR_{t-l} + \sum_{m=0}^{r} \partial_{mINFR} \Delta LNGDP_{t-m}$$
$$+ \sum_{n=0}^{s} \partial_{nINFR} \Delta LNFDI_{t-n} + \psi_{INFR}^1 LNINFR_{t-1} + \psi_{INFR}^2 LNGDP_{t-1} + \psi_{INFR}^3 LNFDI_{t-1}$$
$$+ \sum_{r=0}^{w} \pi_r C_{t,r} + \sum_{e=0}^{v} \in_e D_{t,e} + \mu_{1t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [21]$$

$$\Delta LNGDP_t = a_{0GDP} + a_1 t + \sum_{l=1}^{q} \partial_{lGDP} \Delta LNGDP_{t-l} + \sum_{m=0}^{r} \partial_{mGDP} \Delta LNINFR_{t-m}$$
$$+ \sum_{n=0}^{s} \partial_{nGDP} \Delta LNFDI_{t-n} + \psi_{GDP}^1 LNGDP_{t-1} + \psi_{GDP}^2 LNINFR_{t-1} + \psi_{GDP}^3 LNFDI_{t-1}$$
$$+ \sum_{r=0}^{w} \pi_r C_{t,r} + \sum_{e=0}^{s} \in_e D_{t,e} + \mu_{2t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [22]$$

Where:

GDP	=	Economic growth variable	FDI	=	FDI variable
INFR	=	Infrastructure variable	Δ	=	change
LN	=	logarithm operator	a_0	=	drift component
∂	=	short-run dynamic coefficient	μ_t	=	white noise
ψ	=	the underlying ARDL model long-run multiplier			
C	=	Control variables	D	=	Dummy variable
$a_1 t$	=	Deterministic trend, where applicable.			

In the preceding models, [20-22] the hypotheses tested are:

(i). Overall F-test on all variables lagged levels:

H_0: $\psi^1 = \psi^2 = \psi^3 = 0$ and H_1: $\psi^1 \neq 0, \psi^2 \neq 0, \psi^3 \neq 0$

Reject H_0 if overall F-statistic value exceeds the critical value (upper bound) gotten from Pesaran *et al.* (2001).

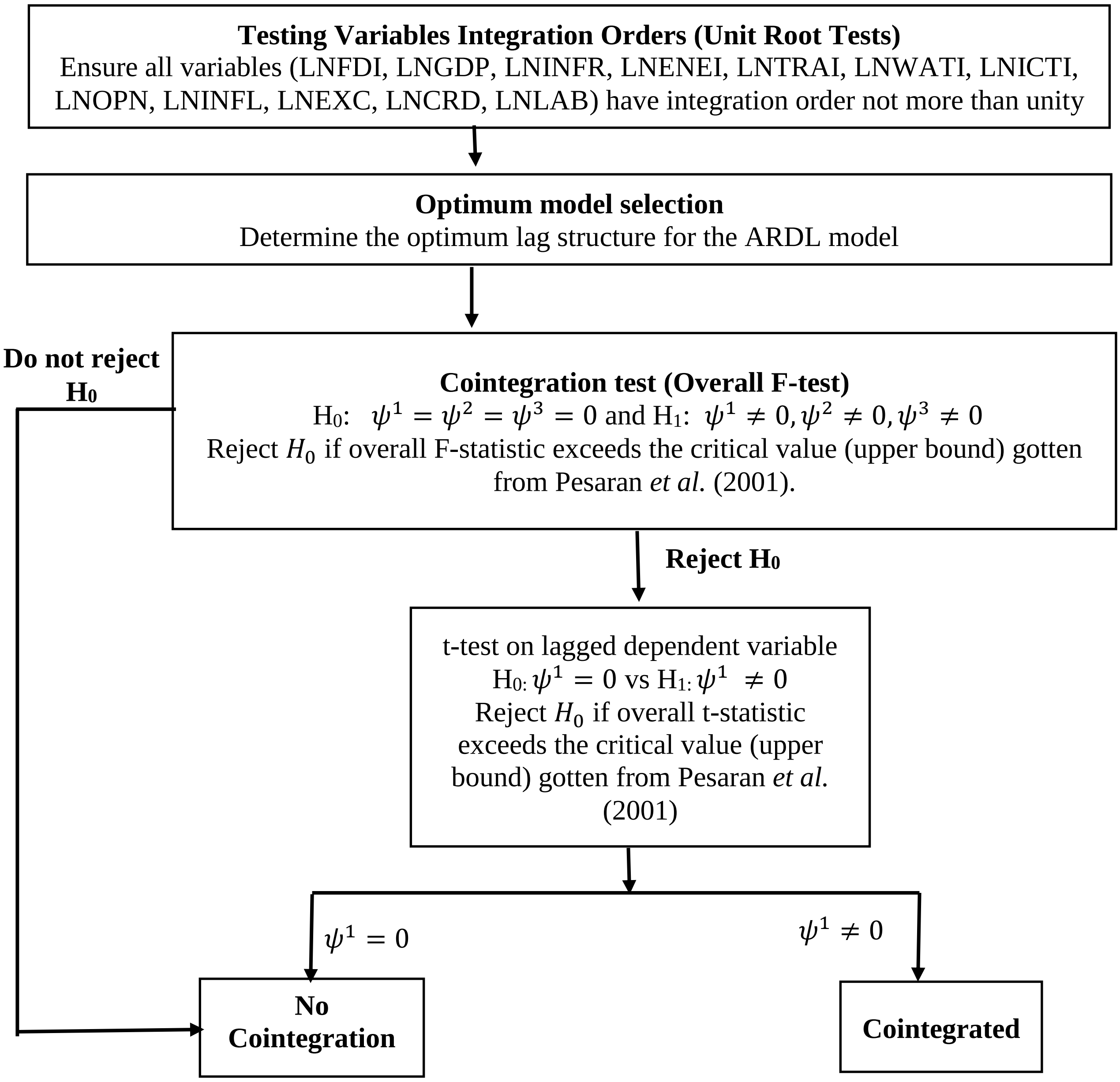
(ii). t-test on lagged dependent variable

$H_0: \psi^1 = 0$ vs $H_1: \psi^1 \neq 0$

Reject H_0 if overall t-statistic exceeds the critical value (upper bound) gotten from Pesaran *et al.* (2001).

Cointegration exists only when hypothesis (i) together with hypothesis (ii) above are both rejected. If there is no rejection of the two hypotheses, then cointegration does not exist.

Figure 4-1: Procedure of Implementing the ARDL Bounds Test



In step 2, the ECM related to the long-run estimates (equations 20-22) is estimated if cointegration of the variables exists to obtain the short-run dynamic parameters. The VECM models are specified as follows:

$$\Delta LNFDI_t = \propto_0 + \propto_1 t + \sum_{j=1}^{q} \emptyset_{1FDIj} \Delta LNFDI_{t-j} + \sum_{j=0}^{r} \emptyset_{2FDIj} \Delta LNGDP_{t-j} + \sum_{k=0}^{s} \emptyset_{3FDIj} \Delta LNINFR_{t-j} + \sum_{r=0}^{w} \pi_r C_{t,r} + \sum_{e=0}^{v} \in_e D_{t,e} + \beta_{FDI} ECT_{t-1} + \varepsilon_t \ldots. [23]$$

$$\Delta LNINFR_t = \propto_0 + \propto_1 t + \sum_{j=1}^{q} \emptyset_{1INFRj} \Delta LNINFR_{t-j} + \sum_{j=0}^{r} \emptyset_{2INFRj} \Delta LNGDP_{t-j} + \sum_{k=0}^{s} \emptyset_{3INFRj} \Delta LNFDI_{t-j} + \sum_{r=0}^{w} \pi_r C_{t,r} + \sum_{e=0}^{v} \in_e D_{t,e} + \beta_{INFR} ECT_{t-1} + \varepsilon_t \ldots [24]$$

$$\Delta LNGDP_t = \propto_0 + \propto_1 t + \sum_{j=1}^{q} \emptyset_{1GDPj} \Delta LNGDP_{t-j} + \sum_{j=0}^{r} \emptyset_{2GDPj} \Delta LNINFR_{t-j} + \sum_{k=0}^{s} \emptyset_{3GDPj} \Delta LNFDI_{t-j} + \sum_{r=0}^{w} \pi_r C_{t,r} + \sum_{e=0}^{v} \in_e D_{t,e} + \beta_{GDP} ECT_{t-1} + \varepsilon_t \ldots.. [25]$$

Where:

β_x = β is the parameter capturing the speed of adjustment towards equilibrium (likely to be negative). x represents the variable of interest (dependent variable). β indicates how fast the current differences in the dependent variable respond to the disequilibrium of the ECT in the immediate past period.

ECT_{t-1} = the lagged error correction term (ECT) estimated from the residual equations in [20-22] and indicates the adjustment speed back to the long-run equilibrium following a shock in the short-run.

$\emptyset_1, \emptyset_2, \emptyset_3,$ the short-run dynamic coefficients of the model's convergence to equilibrium.

If cointegration is not determined to exist among the variables, only short-run ARDL model is specified without the ECT as shown next:

$$\Delta LNFDI_t = \propto_0 + \propto_1 t + \sum_{j=1}^{q} \emptyset_{1FDIj} \Delta LNFDI_{t-j} + \sum_{j=0}^{r} \emptyset_{2FDIj} \Delta LNGDP_{t-j} + \sum_{k=0}^{s} \emptyset_{3FDIj} \Delta LNINFR_{t-j} + \sum_{r=0}^{w} \pi_r C_{t,r} + \sum_{e=0}^{v} \epsilon_e D_{t,e} + \varepsilon_t \dots\dots\dots\dots\dots\dots\dots\dots [26]$$

$$\Delta LNINFR_t = \propto_0 + \propto_1 t + \sum_{j=1}^{q} \emptyset_{1INFRj} \Delta LNINFR_{t-j} + \sum_{j=0}^{r} \emptyset_{2INFRj} \Delta LNGDP_{t-j} + \sum_{k=0}^{s} \emptyset_{3INFRj} \Delta LNFDI_{t-j} + \sum_{r=0}^{w} \pi_r C_{t,r} + \sum_{e=0}^{v} \epsilon_e D_{t,e} + \varepsilon_t \dots\dots\dots\dots\dots\dots\dots [27]$$

$$\Delta LNGDP_t = \propto_0 + \propto_1 t + \sum_{j=1}^{q} \emptyset_{1GDPj} \Delta LNGDP_{t-j} + \sum_{j=0}^{r} \emptyset_{2GDPj} \Delta LNINFR_{t-j} + \sum_{k=0}^{s} \emptyset_{3GDPj} \Delta LNFDI_{t-j} + \sum_{r=0}^{w} \pi_r C_{t,r} + \sum_{e=0}^{v} \epsilon_e D_{t,e} + \varepsilon_t \dots\dots\dots\dots\dots\dots\dots [28]$$

Where $\emptyset_{1,}\ \emptyset_{2,}\ \emptyset_{3,}$ are the dynamic coefficients of the short-run which show the model's convergence to the equilibrium.

INFR will be used at five levels in equations [20-28]: (a) transport infrastructure - TRAI; (b) energy infrastructure - ENEI; (c) ICT infrastructure - ICTI; (d) water infrastructure – WATI; and (e) total infrastructure (composite index) – INFR (calculated using the PCA method).

Equations 23-28 will be estimated by OLS regression separately. All data are expressed in logarithm form so as to ensure that the proliferative effect of time series is included (see Pradhan *et al.*, 2013). The variables time series properties will be tested (see Table *4-3*) before the equations are estimated (see sections 4.2.3 (determination of optimum lag length) and 4.2.4 (time series model diagnostic tests)). The EViews statistical package is used to run the models.

Table 4-3: Testing Variables Time Series Properties

	Test	Test Method
1.	Optimum lag length of the models	Akaike Information Criterion (AIC)
2.	Unite Root	Phillips-Perron (PP); Augmented Dicky-Fuller (ADF); and Kwiatkowski, Phillips, Schmidt and Shin (KPSS)[13]
3.	Goodness of fit	Adjusted R^2
4.	Normality	Jarque-Bera Statistic test
5.	Heteroskedasticity	Breusch-Pagan-Godfrey test
6.	Structural Stability	CUSUM and CUSUM of squares
7.	Serial correlation	Breusch-Godfrey LM test
8.	Functional form	Ramsey RESET test

4.5.1.2 Granger-causality

The ARDL bounds test approach and VECM method determine whether any long-run co-relation exists among the study variables. However, it does not give the direction of causality. The multivariate Granger-causality test is performed (when cointegration is confirmed to exist between two or more variables) using the VECM platform (Engle and Granger, 1987). Three possible causalities are expected among the three main variables of the study, i.e., unidirectional, bidirectional or no causality. The stochastic processes of linear regression modelling is utilised as its mathematical foundation (Granger, 1969). The models for the three main variables of study (INFR, FDI and GDP) and respective hypotheses are presented next. The models show that the dependent variable is being tested for its relation to past values of itself and of the explanatory variable.

$$\Delta LNFDI_t = a_{0FDI} + \sum_{i=1}^{q} \partial_{iFDI} \Delta LNFDI_{t-i} + \sum_{k=1}^{s} \partial_{kFDI} \Delta LNINFR_{t-k} + \mu_{1t} \dots \dots \dots \dots \dots \dots \dots \dots \dots [29]$$

$$\Delta LNFDI_t = a_{0FDI} + \sum_{i=1}^{q} \partial_{iFDI} \Delta LNFDI_{t-i} + \sum_{j=1}^{r} \partial_{jFDI} \Delta LNGDP_{t-j} + \mu_{2t} \dots \dots \dots \dots \dots \dots \dots \dots \dots [30]$$

The null hypotheses being tested for equations [29] and [30] are:

H_0: $\partial_{kFDI} = 0$ - infrastructure development does not Granger cause FDI; and

[13] Unit root tests were carried out to make sure that the variables of study are not integrated of order greater than one, since the ARDL bounds test is applicable only in time series that are I(0) or I(1), or consisting of both.

H$_0$: $\partial_{jFDI} = 0$ - economic growth does not Granger cause FDI.

And alternative hypotheses are:

H$_1$: $\partial_{kFDI} \neq 0$ - infrastructure development Granger causes FDI; and

H$_1$: $\partial_{jFDI} \neq 0$ - economic growth Granger causes FDI.

$$\Delta LNINFR_t = a_{0INFR} + \sum_{i=1}^{q} \partial_{iINFR} \Delta LNINFR_{t-i} + \sum_{k=1}^{s} \partial_{kINFR} \Delta LNFDI_{t-k} + \mu_{3t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [31]$$

$$\Delta LNINFR_t = a_{0INFR} + \sum_{i=1}^{q} \partial_{iINFR} \Delta LNINFR_{t-i} + \sum_{j=1}^{r} \partial_{jINFR} \Delta LNGDP_{t-j} + \mu_{4t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [32]$$

The null hypotheses being tested for equations [31] and [32] are:

H$_0$: $\partial_{kINFR} = 0$ - FDI does not Granger cause infrastructure development; and

H$_0$: $\partial_{jINFR} = 0$ - economic growth does not Granger cause infrastructure development.

And alternative hypotheses are:

H$_1$: $\partial_{kINFR} \neq 0$ - FDI Granger causes infrastructure development; and

H$_1$: $\partial_{jINFR} \neq 0$ - economic growth Granger causes infrastructure development.

$$\Delta LNGDP_t = a_{0GDP} + \sum_{i=1}^{q} \partial_{iGDP} \Delta LNGDP_{t-i} + \sum_{j=1}^{r} \partial_{jGDP} \Delta LNINFR_{t-j} + \mu_{5t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [33]$$

$$\Delta LNGDP_t = a_{0GDP} + \sum_{i=1}^{q} \partial_{iGDP} \Delta LNGDP_{t-i} + \sum_{k=1}^{s} \partial_{kGDP} \Delta LNFDI_{t-k} + \mu_{6t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [34]$$

The null hypotheses being tested for equations [33] and [34] are:

H$_0$: $\partial_{jGDP} = 0$ - infrastructure development does not Granger cause economic growth; and

H$_0$: $\partial_{kGDP} = 0$ - FDI does not Granger cause economic growth.

And alternative hypotheses are:

H$_0$: $\partial_{kGDP} \neq 0$ - infrastructure development Granger causes economic growth; and

H$_0$: $\partial_{jGDP} \neq 0$ - FDI Granger causes economic growth.

Results of the F-statistics [14] determine rejection or non-rejection of the above null hypotheses. The decision criteria for the rejection of the null hypothesis: if the *p*-value of the F-statistic is $\leq$ 0.05.

4.6 Chapter Summary

The chapter began with the review and choice of the variables and methodologies to analyse the relationship among infrastructure development, FDI and economic growth. As the main dependent variable in this study is FDI, other determinants of FDI identified in the literature review were proposed to be included as exogenous variables (control variables). These determinants of FDI and which also affect economic growth are inflation, exchange rate, trade openness, financial development, and labour force. The few widely used control variables were chosen owing to the small sample size, and to avoid an overfit model that can cause misleading R-squared, and regression coefficients and p-values.

The ARDL bounds test method is the proposed technique for analysing the study models because of inherent characteristics and the study objectives. Furthermore, the ARDL bounds test allows for the approximation of the long-run and short-run parameters of the models simultaneously and leads to the determination of the existence of causality between variables of the study. The ARDL technique is considered better than all other cointegration methods as it is usable in both stationary and non-stationary series and in situations composed of both stationary and non-stationary series. ARDL is also used to estimate cointegration where there is a small sample size. The model specification for this study is built around the ARDL bounds test method as specified in Pesaran *et al.* (2001).

[14] The overall F-test is not statistically significant when no independent variables is statistically significant. Econometric software used to calculate the F-statistic which is interpreted accordingly.

The procedures of testing the robustness of the models being run and the findings of the analysis are given in this chapter. This includes the determination of optimum lags and the time series models diagnostic tests. The unit root test that determines the stationarity of the study variables is also identified as a necessary test in the analysis of the time-series data, and especially as a prerequisite for the final decision to utilise the ARDL bounds technique.

In line with previous similar studies, the growth rate of GDP per capita and FDI net inflows as a percentage of GDP are the preferred proxies to represent economic growth (market size) and FDI in the study. Infrastructure proxies include the length (km) of paved roads, telephony connections, electricity effective installed capacity, and expenditure on water supplies. An aggregate index also represents infrastructure development (consisting of all infrastructure variables) build through the PCA process. These chosen variables are justified, defined and their sources indicated. The sample size is also presented and justified. This study utilises the 1970-2019 annual time series dataset.

In the next chapter, the empirical findings and results emanating from the estimations of the models and tests specified in this chapter are presented. The findings of the empirical results determine the validity of the study hypotheses.

CHAPTER FIVE
EMPIRICAL FINDINGS

5.1 Introduction

The predicted impacts existing between FDI, infrastructure (INFR) and economic growth (GDP) as given under study hypotheses, are discussed in chapters two and three on this thesis, under literature review, while the proposed models for analyses were presented and discussed in chapter four, under research methodology. All the variables of interest in the study are predicted to influence one another positively; that is, to be cointegrated. It is predicted that there is a positive bidirectional causal relationship between FDI and infrastructure. In the same way, a bidirectional causal relationship is also expected between FDI and economic growth, as well as between economic growth and infrastructure development.

This chapter consists of the findings of the analyses emanating from running the models constructed in chapter four (methodology). The analyses are performed as defined in the methodology chapter to determine the validity of the study hypotheses, with all identified and justified methodological procedures followed. Five sets of analyses are done, with FDI and economic growth analysed separately with either infrastructure composite index, transport infrastructure, energy infrastructure, ICT infrastructure, or water infrastructure. Control variables that are selected from the main determinants of FDI inflows are included in the analyses. This arrangement of analyses ensures that the study's main objectives are achieved, and the relationship between FDI, economic growth and infrastructure are satisfactorily examined.

The conclusions made from model analyses and determination of the validity of study hypotheses are based on the statistical significance of estimated models.

5.2 Data and Unit Root Tests

5.2.1 Variables

The proxy variables utilised in the study are FDI net inflows as a percentage of GDP to represent FDI, the growth rate of GDP per capita to represent economic growth and the infrastructure composite index to represent infrastructure development. Other proxies that are used to represent infrastructure in testing the cointegration and Granger causality between FDI, economic growth and infrastructure development are: length (km) of paved roads – representing transport (TRAI), telephone connections (total mobile telephony and fixed lines connections - number of persons) – representing ICT technology (ICTI), electricity installed capacity (MW) - representing energy (ENEI), and national government development expenditure on water supplies - representing water (WATI). The data from the four distinct infrastructure proxies (TRAI, ICTI, ENEI and WATI) are used to formulate the infrastructure (INFR) variable (composite index) through the PCA. The control variables included are inflation rate, exchange rate, the total of imports and exports divided by GDP (representing trade openness), domestic credit to the private sector (representing financial development) and annual percentage change in secondary school enrolment (proxying labour force).

5.2.2 Infrastructure (INFR) Variable

In the analysis, infrastructure appears in two ways: (1) at the sub-sector level, where transport (TRAI), energy (ENEI), ICT (ICTI) and water (WATI) are analysed distinctively, and (2) INFR at the whole level (composite index), where all infrastructures are linked contemporaneously. That is, TRAI, ENEI, ICTI and WATI are combined to produce the INFR composite index through the PCA method.

The SPSS is utilised to derive the composite variable through the PCA. The SPSS PCA derived results are presented next:

Table 5-1: KMO and Bartlett's Test

KMO	Bartlett's Test		
	Approximate of Chi-Square	degrees of freedom (df)	Significance
0.703	247.212	6	0.000

Table *5-1* gives results from the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's sphericity test of the fitness of the data for structure detection. The KMO statistic shows the portion of the variables variance that is most likely attributed to the underlying factors. Therefore, in factor analysis, statistics closer to 1.0 are preferred and hence useful than values less than 0.50. The value obtained in Table 5-1, which is 0.703, is therefore sufficient for PCA.

The comparison of the observed correlation matrix to the identity matrix is done using Bartlett's sphericity test. If the correlation matrix is closer to the identified matrix, it means that the variables are related and therefore not suitable for structure detection. A value closer to one (1) is not preferred, while a value closer to zero (0) is useful because it indicates that the variables are unrelated. Hence, Bartlett's test significance value of 0.000 obtained in the above analysis given in Table 5-1 is ideal for the factor analysis (PCA).

Table 5-2: Extraction Communalities

	Extraction
ENEI	0.935
TRAI	0.895
WATI	0.296
ICTI	0.948

The extraction communalities are assessments of the individual contribution of the variables considered to the factor solution. Smaller values point to variables that do not contribute substantially to the factor solution and should perhaps be excluded. The values in Table 5-2 and Table 5-3 suggest that the four variables of analysis reasonably fit well in the determination of the composite index. WATI has the weakest contribution to the creation of the index. However, WATI is included to ensure that the composite index is representative of the four sectors (transport, energy, ICT and water) used to represent physical infrastructure in the study. Not contributing significantly to the factor solution does not imply that a variable should be excluded.

Table 5-3: Initial Solution Total Variance Explanation

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	Per cent of Variance	Cumulative per cent	Total	Per cent of Variance	Cumulative per cent
1	3.074	76.851	76.851	3.074	76.851	76.851
2	0.822	20.554	97.405			
3	0.078	1.948	99.353			
4	0.026	0.647	100.000			

The second column of Table 5-3 above illustrates the variance associated with the initial solution. The result reveals that one factor from the initial solution has an eigenvalue larger than 1 and contributes 76.851 per cent of the changes in the original variables, indicating a substantial explanation of the variation. This is further confirmed by results shown under extraction sums of squared loadings, which has the same cumulative variability of 76.851 per cent.

Table 5-4: Component Matrix

	Component
	1
ENEI	0.967
TRAI	0.946
WATI	0.544
ICTI	0.974

The one component extracted is highly correlated (over 0.50) in the four variables (transport, energy, ICT, and water). Therefore, the INFR composite index is a reliable variable that is a linear combination of ENEI, TRAI, WATI, and ICTI. All the data used in the analysis, including INFR composite index, are presented in Appendix 1.

5.2.3 Dummy Variable

A dummy variable is incorporated in the model to account for the effects of a major change of government in 2002. The change in government in 2002 culminated in the shift of major policies, including increased public expenditure on infrastructure development. The Bai-Perron (2003) multiple breakpoint tests determined the existence of a breakpoint in 2004.

Table 5-5: Multiple Breakpoint Tests (Bai-Perron Tests)

Sequential F-statistic determined breaks: 1			
Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	9.882454	9.882454	8.58
1 vs. 2	2.126676	2.126676	10.13
Break dates:			
	Sequential	Repartition	
1	2004	2004	

** Significant at the 0.05 level.*
*** critical values from Bai-Perron (Econometric Journal, 2003).*

The one estimated break date in 2004 was found through the Bai-Perron sequential breakpoint methodology, with 5 breaks (maximum), 5 per cent trimming and a 10 per cent significance level test size. The White's method without correction of degrees of freedom was used to calculate the coefficient covariances for the tests and estimates. The sequential test results indicate that there is one breakpoint where the null of 0 breakpoints is rejected in favour of the alternative of 1 breakpoint, though the test of 2 versus 1 breakpoint fails to reject the null.

Therefore, the dummy variable was created where 1970-2003 take values 0, while 2004-2019 take values 1. This is because the change of policies affected the economy well after 2002, including increasing infrastructure investments (see Figure 1-1). The break caused a jump in the series, which continues after the break.

5.2.4 Descriptive Statistics

Table 5-6 shows descriptive statistics of the study variables. The rows present the variables mean, median, maximum value, minimum value, standard deviation, skewness, kurtosis and Jarque-Bera test for normality. The probability values (small values) imply that the series is not normally distributed since the null hypothesis is rejected. The sample size is for the period 1970-2019.

The highest real FDI inflows (FDI inflows as % of GDP) was recorded in 2011 of 3.457 per cent of GDP and amounted to Kenya shillings (Ksh) 1.13 billion net inflows, while the lowest was realised in 1988 of 0.005 per cent of GDP (Ksh 1.1 million). Since 1970 FDI inflows to Kenya have been averaging Ksh 212 million per year. The growth rate of GDP per capita has averaged 1.369 per cent, with the highest rate being 17.880 per cent growth recorded in 1971 and the lowest growth realised in 1970 (-7.952 per cent growth). Electricity installed generation capacity in Megawatt (MW) has grown from 153.21 MW in 1970 to 2,818.9 MW in 2019.

The paved road network has expanded from 2,936 km in 1970 to 21,295.11 km in 2019, an increase of 18,359.11 km. The national government's real expenditure on water supplies (expenditure on water supplies/Kenya consumer price index) was the highest in 1977 (Ksh 415 million) and lowest in 1988 (Ksh 27.9 million). The total number of telephone connections (mobile and fixed line) has increased from 35,538 connections in 1970 to 54.6 million connections in 2019.

Table 5-6: Descriptive Summary Statistics of Study Variables

	FDI	GDP	INFR	TRAI	ENEI	ICTI	WATI	OPN	INFL	EXC	CRD	LAB
Mean	0.808	1.369	0.0000	8,569.88	993.49	8,742,392	149,000,000	0.433	11.626	47.902	23.605	958,689
Median	0.510	1.243	-0.333	8,666.45	813.30	242,478	136,000,000	0.424	9.898	56.583	21.982	636,562
Maximum	3.457	17.880	2.999	21,295.11	2,818.90	54,577,600	415,000,000	0.723	45.979	103.410	40.204	3,260,000
Minimum	0.005	-7.952	-1.214	2,936.00	153.21	35,538	27,931,168	0.263	1.554	7.001	15.119	126,855
Std. Dev.	0.762	3.967	1.000	3,877.97	677.91	15,359,285	83,065,482	0.105	8.046	34.690	5.986	818,279
Skewness	1.572	1.568	1.422	1.169	1.098	1.623	0.808	0.285	1.920	0.086	1.055	1.381
Kurtosis	5.186	8.680	4.093	4.732	3.512	4.256	3.582	2.846	8.238	1.419	3.616	3.824
Jarque-Bera	30.558	87.712	19.329	17.629	10.585	25.232	6.150	0.728	87.897	5.270	10.070	17.297
Probability	0.000	0.000	0.000	0.000	0.005	0.000	0.046	0.695	0.000	0.072	0.007	0.000
Observations	50	50	50	50	50	50	50	50	50	50	50	50

Where:

FDI = FDI inflows (as % of GDP); GDP = economic growth represented by the growth rate of GDP per capita; INFRA = infrastructure composite index; TRAI = transport infrastructure proxied by the length (kilometres) of paved roads; ENEI = energy infrastructure proxied by electricity installed generation capacity; ICTI = ICT infrastructure represented by telephony connections; WATI = water infrastructure represented by real national government expenditure on the development of water supplies and related services; OPN = trade openness; INFL = inflation rate; EXC = exchange rate (KSH/USD); CRD = financial development represented by domestic credit to the private sector (% of GDP); LAB = labour force (human resource) represented by secondary school enrolment (no of students).

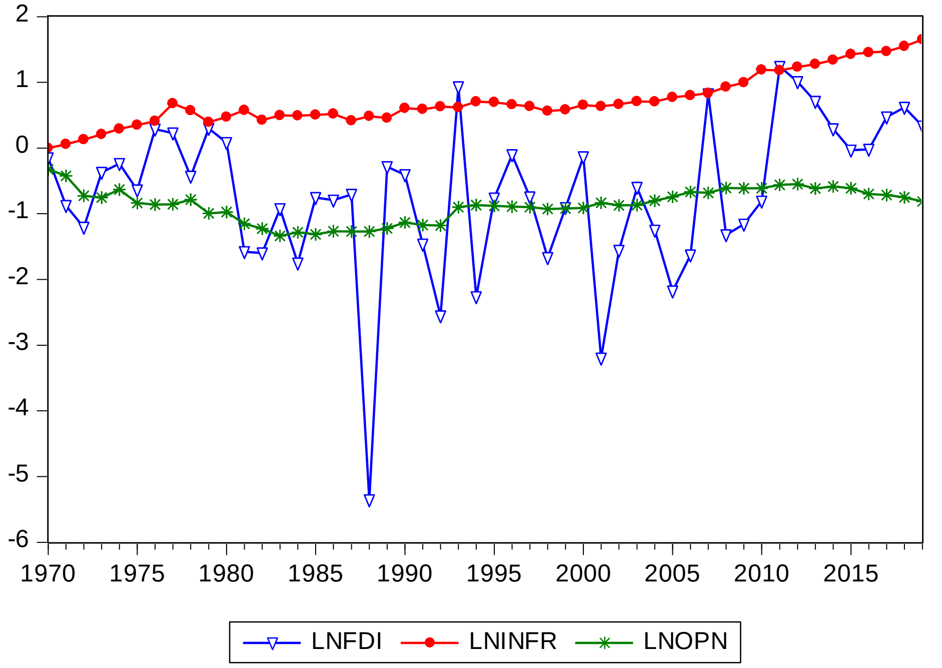
5.2.5 Unit Root Tests and Empirical Approach

In investigating the effects of infrastructure development on FDI inflow and economic growth, annual time series data is used. The data used include the logarithm of the growth rate of GDP per capita (LNGDP), the logarithm of Real FDI net inflows as per cent of GDP (LNFDI), the logarithm of infrastructure (LNINFR), the logarithm of length (km) of paved roads (LNTRAI), the logarithm of the number of telephone connections (LNICTI), the logarithm of electricity installed capacity in megawatt (LNENEI), and the logarithm of the national government real expenditure on water supplies (LNWATI). Other variables included are the logarithm of trade openness (LNOPN), the logarithm of inflation rate (LNINFL), the logarithm of the exchange rate (LNEXC), the logarithm of domestic credit to the private sector as a percentage of GDP (LNCRD), and the logarithm of the number of students enrolled in secondary school (LNLAB).

In most of the time-series data, the logarithm transformation of the positive variables is easily applied since taking logarithms of negative numbers are not defined in the real numbers. Taking a logarithm of a negative number leads to an undefined result. GDP and INFR were adjusted by adding 8.95 and 2.12, respectively, to enable logarithms to be taken from positive numbers (see King'ori, 2007). This is done by adding respective constant values (+8.95 to GDP and +2.25 to INFR) to the data before applying the logarithm transformation (log(Y+a) where a is the constant. Hence, the values of the two observations (GDP and INFR) were above one (1) before the transformation.

To this effect, the time series graphical behaviour of the transformed dataset is presented in figures 5-1 to 5-4.

Figure 5-1: Time Series Plots of LNFDI, LNINFR and LNOPN (1970-2019)



LNFDI, LNINFR and LNOPN exhibit rising trends implying that linear trends need to be considered when undertaking the unit root tests.

Figure 5-2: Time Series Plots of LNGDP and LNINFL (1970-2019)

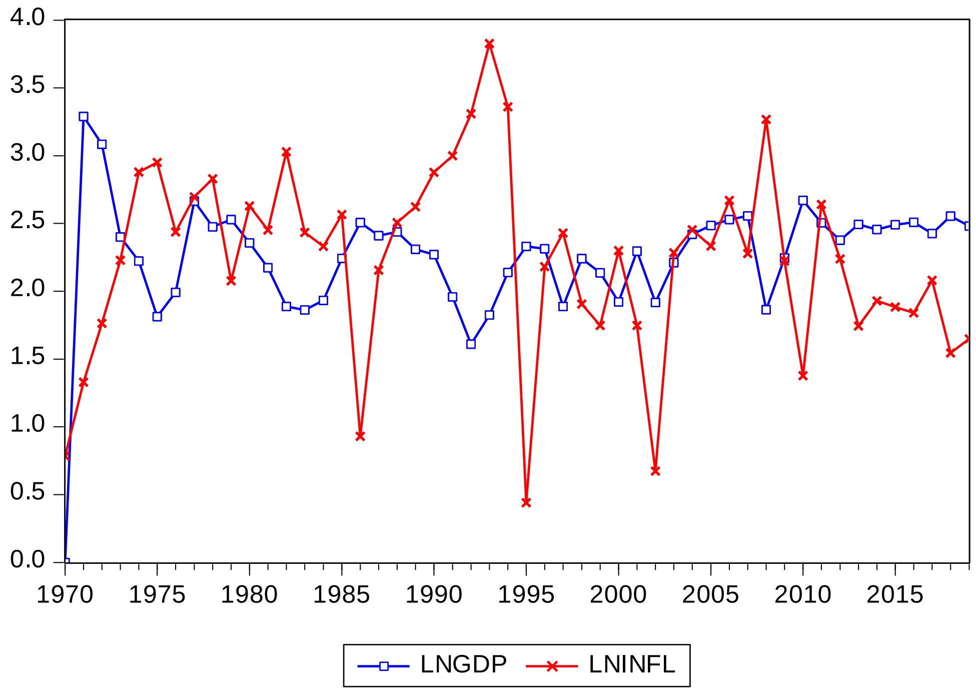


Figure 5-2 shows there is a time trend in LNGDP and LNINFL variables. As such, linear trends need to be considered when undertaking the unit root tests of the two variables.

Figure 5-3: Time Series Plots of LNENEI, LNTRAI, LNICTI, LNWATI and LNLAB (1970-2019)

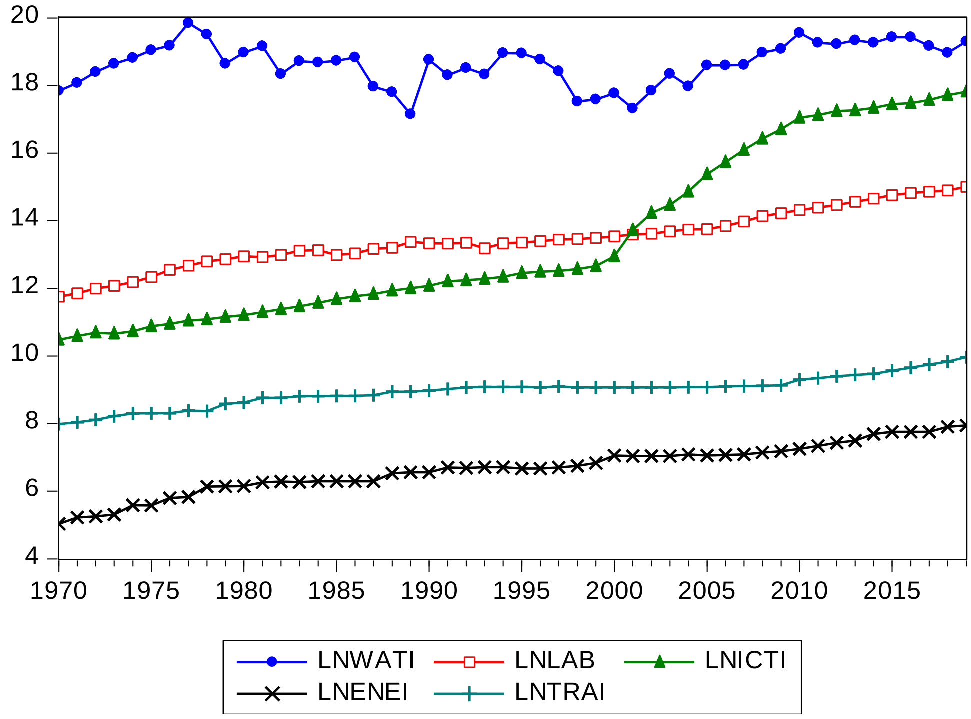


Figure 5-3 shows that LNWATI, LNLAB, LNICTI, LNENEI and LNTRAI exhibit rising trends implying that linear trends need to be considered when undertaking their unit root tests.

Figure 5-4: Time Series Plots of LNEXC and LNCRD (1970-2019)

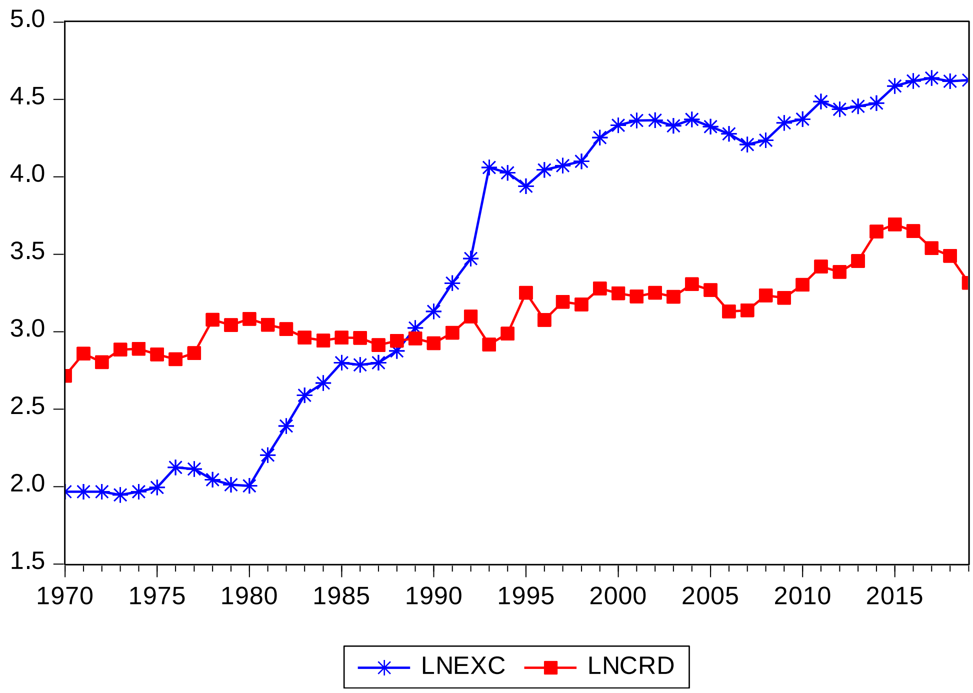


Figure 5-4 shows that LNEXC and LNCRD have rising trends and thus linear trends need to be considered when undertaking their unit root tests. The rising trends exhibited by the variables of analysis imply that linear trends need to be considered when undertaking the unit root tests. Moreover, the models of analysis would require that we have series not centred about zero, and therefore, a constant term is recommended to be included.

Table 5-7: Unit Root Tests

	ADF		PP		KPSS
	Level	First Differenced	Level	First Differenced	Level
LNFDI	-1.4401	-8.9421***	-6.1495***	-	0.1898**
LNGDP	-9.3180***	-	-8.4685***	-	0.1211*
LNINFR	-0.7926	-3.6157***	-0.9898	-7.3905***	0.1695**
LNENEI	-3.0774	-7.9426***	-3.0741	-7.8526***	0.1274*
LNTRAI	-1.9392	-2.4245	-1.5992	-5.7904***	0.1346*
LNWATI	-2.7850	-8.6620***	-2.7426	-8.7199***	0.1402*
LNICTI	-2.2746	-2.7759*	-1.5992	-2.7759*	0.2033**
LNOPN	-2.7793	-6.5536***	-3.2137*	-6.5574***	0.1768**
LNINFL	-5.3726***	-	-5.3523***	-	0.0878
LNEXC	-0.7501	-5.3683***	-1.0407	-5.3683***	0.1757**
LNCRD	-3.3627*	-7.7984***	-3.2297	-7.7994***	0.8298*
LNLAB	-1.7933	-5.7322	-2.019	-5.8098***	0.1216*

Note: (***) Significant at the 1%; (**) Significant at the 5%; (*) Significant at the 10%

The summary of unit root tests is presented in Table 5-7. The tests are carried out using the ADF, PP and KPSS tests. In testing the level of the series, the intercept, as well as the trend components, are included, while in testing the first differenced series, the intercept is the sole inclusion since differencing handles the trend effects. In the unit root tests, the length of the lags is determined using the Akaike Information Criterion (AIC), while in the PP and KPSS, use was made of the Newey-West method for determination of the bandwidth and Bartlett kernel for spectral estimation. The AIC option is not available in the PP and KPSS testing under the utilised EViews software.

Based on the findings of the unit root tests, study variables tested are integrated in order zero and order one [1(0) and 1(1)]. Therefore, the ARDL bounds testing approach is ideal for determining if variables are cointegrated. The ARDL bounds method is the most ideal for analysing data that are a combination of I(1) and I(0) series (see Pesaran *et al.*, 2001). The ARDL model consists of lagged values of the dependent variable, current values of the regressors and lagged values of the regressors. Johansen's test of cointegration is not applicable where variables of the study are together I(0) and I(1). An ARDL model can include endogenous and exogenous variables, unlike the VAR model, which includes only endogenous variables. The use of the ARDL bounds test does not require prior testing of variables for stationarity except to verify that the variables of the study are not integrated of orders higher than I(1) (Pesaran *et al.*, 2001).

In the analysis, ARDL bounds test is deployed to determine cointegration, ECM is deployed to determine long-run and short-run dynamics, while the Granger causality test is deployed to determine whether the study hypotheses are valid, are carried out through the following estimation process:

- Specification of the ARDL bounds test model.
- Determine the optimal lag structure.
- Run the ARDL regression and the model diagnostics, including tests for the residual normality, serial correlation and heteroskedasticity, and model specification error and parameter stability.
- Undertake ARDL bounds test to verify series cointegration.
- Specify VECM to investigate long-run dynamics if series are cointegrated.
- Specify only short-run ARDL model when series are determined not to be cointegrated.
- Undertake important diagnostic on ARDL short-run and VECM models, including the test for residual serial correlation, heteroskedasticity, and model specification error.
- Undertake Granger causality to test the study hypotheses.

5.3 Empirical Results

The optimal lag lengths, structural stability tests and residual diagnostic tests are performed to ensure model suitability for the ARDL cointegration tests.

5.3.1 Optimal Lag Lengths

The determined optimal lag lengths applicable to the five sets of equations under examination are presented in Table 5-8:

Table 5-8: Optimal Lag Lengths

Set of Equation	Dependent Variables	Exogenous Variables	Lag length
1.	LNFDI, LNGDP, LNINFR	LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	3
2.	LNFDI, LNGDP, LNENEI	LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	1
3.	LNFDI, LNGDP, LNTRAI	LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	4
4.	LNFDI, LNGDP, LNWATI	LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	2
5.	LNFDI, LNGDP, LNICTI	LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	3

In running the ARDL bounds cointegration equation, the above optimal lag selection method is augmented with the EViews specialised built-in optimal lag-length selection estimation. In EViews, ARDL models are estimated by applying an equation object with the OLS method of estimation (IHS Global, 2017). EViews provides a specialised built-in optimal lag-length selection estimator for handling ARDL models. The automatic lag selection criteria for ARDL models choose an ideal lag length that minimises the residual sum of squares and favourable diagnostic results that lend validity to regression estimations. Consequently, this study uses the EViews automatically selected lags in model regression geared towards the determination of the ARDL bounds cointegration test where AIC is the choice information criterion to select the lags.

5.3.2 Cointegration Test and Validation of Hypotheses

The test for cointegration among economic growth, FDI and infrastructure is performed within the ARDL approach. In this study, cointegration is confirmed only when the two hypotheses on the overall F-test (F-Bounds Test) and the t-test (t-Bounds Test) are rejected; otherwise, there is no cointegration (see section 4.5.1.1 and Figure 4-1).

Once the overall F-statistic and the t-statistic both exceed the respective upper bound critical values, a conclusion on the presence of cointegration can be reached. Thereafter, the study proceeds to the error correction (ECM) regression to assess long-run dynamics and ARDL short-run specification to analyze short-run causality. Suppose both F-statistic and t-statistic are not significant, and cointegration is ruled out among the variables being observed. In that case, the study proceeds only with ARDL short-run specification to assess if short-run causality exists. However, model diagnostics are performed in all cases to rule out biases and errors.

When undertaking the ARDL bound cointegration test, the EViews software calculates the F-statistics and t-statistics which are compared with the respectable lower bound and upper bound critical values (Pesaran *et al.*, 2001). In comparing the calculated F-statistics and the t-statistic with the lower and upper bounds critical values, the aim is to accept or reject the null hypotheses of no cointegration among the dependent variable and the equation's regressors. The critical values to be compared with the statistics from the analysis are for 10 per cent, 5 per cent and 1 per cent significance levels. The overall F-statistic is for testing the significance of the relationship between the lagged vector and the respective regressors, and the t-statistic tests the significance of the lagged values of the dependent variable. The upper and lower bounds critical values are presented in Table 5-9.

Table 5-9: Upper and Lower Bounds Critical Values

	Lower Value			Upper Value		
Probability	0.010	0.050	0.100	0.010	0.050	0.100
(i). Overall F-test						
Unrestricted intercepts, no trends	5.51	3.79	3.17	6.36	4.85	4.14
Unrestricted intercepts, unrestricted trends	6.34	4.87	4.19	7.52	5.85	5.06
(ii). t-test						
Unrestricted intercepts, no trends	-3.43	-2.86	-2.57	-4.10	-3.53	-3.21
Unrestricted intercepts, unrestricted trends	-3.96	-3.41	-3.13	-4.53	-3.95	-3.63

Source: Pesaran et al. 2001. The total of explanatory variables is 2 (K=2) in all equations for asymptotic: n=1000.

Five sets (3 each) of a total of fifteen (15) equations are included in the ARDL model analyses and Granger causality test. The lag values of dependent and explanatory variables are included as regressors in the equations. The constant term and the deterministic trend (if statistically significant) are also included as regressors. These equations are:

Table 5-10: Cointegration and ECM Equations

Set	Equations	Dependent Variable	Independent Variables
1.	1.	LNFDI	LNGDP, LNINFR, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB
	2.	LNGDP	LNFDI, LNINFR, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB
	3.	LNINFR	LNFDI, LNGDP, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB
2.	4.	LNFDI	LNGDP, LNENEI, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB
	5.	LNGDP	LNFDI, LNENEI, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB
	6.	LNENEI	LNFDI, LNGDP, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB
3.	7.	LNFDI	LNGDP, LNTRAI, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB
	8.	LNGDP	LNFDI, LNTRAI, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB
	9.	LNTRAI	LNFDI, LNGDP, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB
4.	10.	LNFDI	LNGDP, LNWATI, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB
	11.	LNGDP	LNFDI, LNWATI, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB
	12.	LNWATI	LNFDI, LNGDP, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB
5.	13.	LNFDI	LNGDP, LNICTI, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB
	14.	LNGDP	LNFDI, LNICTI, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB
	15.	LNICTI	LNFDI, LNGDP, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB

After determining on the existence of cointegration using the ARDL bounds approach, the set of equations found to have cointegration are further subjected to error correction regression investigation. The error correction regression investigation leads to determining the long-run dynamics (error correction) and the adjustment of series back to equilibrium. Suppose no cointegration is determined to exist in the analysis of the equation, a short-run model regression is carried out to determine the short-run causal effect of the regressors on the dependent variable. Finally, the Granger causality test is undertaken to test the study's null hypotheses. EViews raw outputs from the study analyses are presented in Appendix 2.

5.3.2.1 Relationship Between LNFDI, LNGDP and LNINFR

The findings of the ARDL model regression (standard least-squares output), diagnostic tests, the test of cointegration, error correction regression and test for Granger causality for the relationship between FDI (LNFDI), economic growth (LNGDP) and infrastructure (LNINFR) are presented in this section. The ARDL model regression involving FDI, GDP and LNINFR, and selected control variables is presented in Table 5-11.

Table 5-11: ARDL Model Regression (Dependent Variables - LNFDI, LNGDP, LNINFR)

	Equation 1	Equation 2	Equation 3
Output Variable	LNFDI	LNGDP	LNINFR
Selected Model	(3,0,3)	(4,0,0)	(1,1,1)
Regressors			
LNFDI	-	-0.008785 (0.7517)	0.003053 (0.7893)
LNFDI(-1)	-0.579512*** (0.0026)		0.019134 (0.0980)
LNFDI(-2)	-0.620573*** (0.0014)	-	-
LNFDI(-3)	-0.262945 (0.1394)	-	-
LNGDP	-0.717498 (0.3375)	-	-0.016860 (0.7258)
LNGDP(-1)	-	0.153293 (0.3245)	-0.002911 (0.9063)
LNGDP(-2)	-	-0.216145 (0.1898)	-
LNGDP(-3)	-	-0.201258 (0.0980)	-
LNGDP(-4)	-	-0.193838** (0.0131)	-
LNINFR	-0.148969 (0.9478)	0.056466 (0.8792)	-
LNINFR(-1)	3.737901 (0.1879)	-	0.614213*** (0.0001)

LNINFR(-2)	3.091827 (0.2676)	-	-
LNINFR(-3)	3.717852 (0.0942)	-	-
LNOPN	4.553645*** (0.0017)	0.380836 (0.1894)	0.183406 (0.0628)
LNINFL	-0.158061 (0.5919)	-0.115409** (0.0287)	-0.016347 (0.4449)
LNEXC	-1.357449*** (0.0081)	-0.256912** (0.0278)	-0.048738 (0.1440)
LNCRD	0.323876 (0.8563)	-0.414094 (0.1973)	-0.193829 (0.1281)
LNLAB	-2.620241 (0.0822)	0.337745 (0.2881)	0.264921*** (0.0067)
DUM	-0.527423 (0.5335)	0.200246 (0.2094)	-0.015121 (0.8067)
Constant	36.56118 (0.0318)	1.428874 (0.6433)	-2.226721 (0.0375)
Adjusted R^2	0.439594	0.532253	0.965384
DW statistic	2.150793	2.086363	2.051124
F-statistic	3.577383*** (0.0014)	5.267163*** (0.0001)	122.6964*** (0.0000)

*The First line contains estimated coefficients. In parenthesis () are the probability values (p-values). Emphasis is placed on *** p<0.01 (Significant at 1 per cent level) and ** p<0.05 (Significant at 5 per cent level). Each term's p-value tests the null hypothesis of no effect from the respective independent variable on the regressand (that coefficient is equal to zero). Therefore, the null hypothesis can be rejected when the p-value is low (< 0.05). DW is the Durbin-Watson statistic.*

The above ARDL model regression output is the standard least-squares output for the selected three models. The deterministic trends were insignificant at the 10 per cent level in all the equations and therefore were excluded in the analysis.

The EViews generated optimum lag lengths for the equations are presented in the order (dependent variable lags, first dynamic regressor's lags, second dynamic regressor's lags). From Table 5-11, the optimum lag lengths are (3, 0, 3), (4, 0, 0) and (1, 1, 1) for the equations where LNFDI, LNGDP and LNINFR are the dependent variables, respectively. The selection of the optimum lag length ensures that the equation chosen passes important diagnostic tests to ensure the validity of the regression results. The explanatory variables explain 44.0 per cent, 53.2 per cent and 96.5 per cent of the changes in the dependent variable in the three equations as shown by the respective adjusted R-squared statistics in Table 5-11. The *p*-values associated with the

F-statistics in all three equations are less than 1 per cent (< 0.01), meaning that at least one independent variable is related to the dependent variable in each equation.

The Durbin-Watson statistics in the three equations are greater than 1.98597 (upper bound value), i.e., $D > D_U$ for a sample size of 50 observations (1970-2019) and ten terms (including the intercept and the dummy variable). Therefore, there is no clearly determined positive correlation between adjacent error terms in either of the three equations (see Savin and White, 1977).

The null hypothesis of no effect of the explanatory variable on the independent variable is rejected when the p-value is low (< 0.05). The p-values from equation 1 indicate that past levels of FDI inflows have a negative effect on current FDI inflows. Results from equation 1 further show that market openness (p-value 0.0017, coefficient 4.5536) has a positive effect and exchange rate (p-value 0.0081, coefficient -1.3574) has a negative effect on FDI.

The four-period lag of economic growth (p-value 0.0131, coefficient -0.1938), inflation (p-value 0.0287, coefficient -0.1154) and exchange rate (p-value 0.0278, coefficient -0.0278) have negative effect on economic growth. The one-period lag of infrastructure variable (p-value 0.0001, coefficient 0.6142) and labour force (p-value 0.0067, coefficient 0.2649) have positive effect on infrastructure development.

Table 5-12: Diagnostic Tests (LNFDI, LNGDP and LNINFR)

Equation	Dependent Variable	Independent Variables	Ramsey RESET	Jarque-Bera Statistic	Breusch-Godfrey LM	Breusch-Pagan-Godfrey
1.	LNFDI	LNGDP, LNINFR, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	6.7007** (0.0144)	3.5173 (0.1723)	0.5045 (0.3507)	1.0771 (0.4121)
2.	LNGDP	LNFDI, LNINFR, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	0.3285 (0.5706)	4.3139 (0.1157)	0.1338 (0.8752)	0.6012 (0.8253)
3.	LNINFR	LNFDI, LNGDP, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	4.7586 (0.3580)	4.3362 (0.1144)	2.0547 (0.1442)	0.8942 (0.5544)

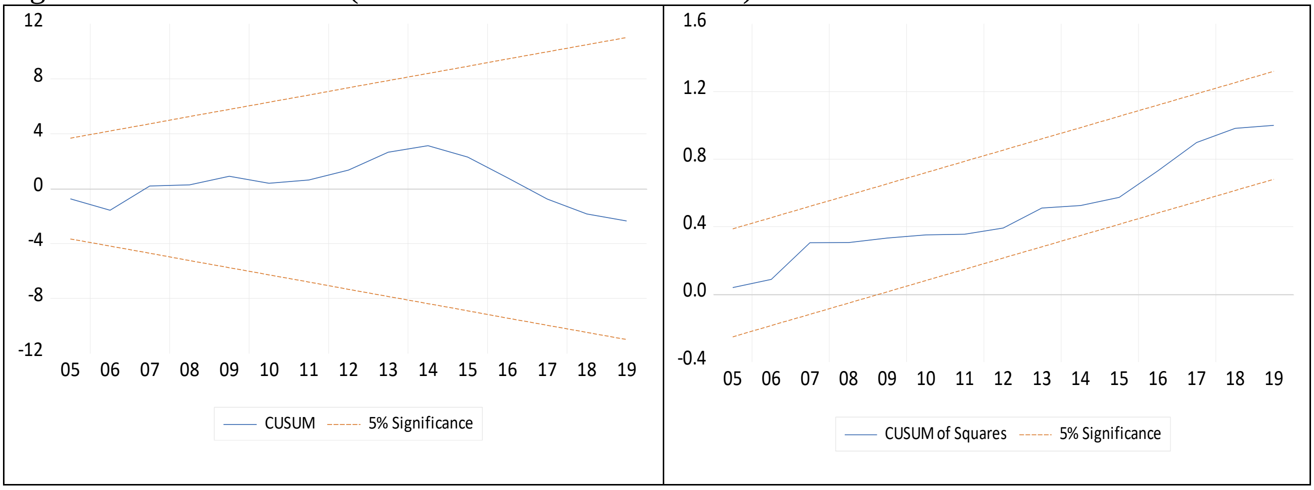
*The F statistics on the first line, probability values in parenthesis (). Emphasis is placed on *** p<0.01 (Significant at 1 per cent level) and ** p<0.05 (Significant at 5 per cent level). Low p-values (< 0.05) indicate the existence of diagnostic abnormality, and the null hypothesis cannot be rejected[15].*

From Table 5-12, it is evident that the three equations pass most of the critical diagnostics (all p-values >0.05), including the Breusch-Godfrey Lagrange multiplier test for no serial correlation in the residuals and heteroskedasticity test (Breusch-Pagan-Godfrey). The test of no functional misspecification (Ramsey RESET) fails in equation 1. However, equation 1 is stable, as shown in Figure 5-5. Parameter stability in the model is demonstrated as the CUSUM plots do not deviate from the 5 per cent significance level boundary.

The CUSUM and CUSUM of squares tests for parameter stability are satisfactory – look at Figure 5-5, Figure 5-6 and Figure 5-7.

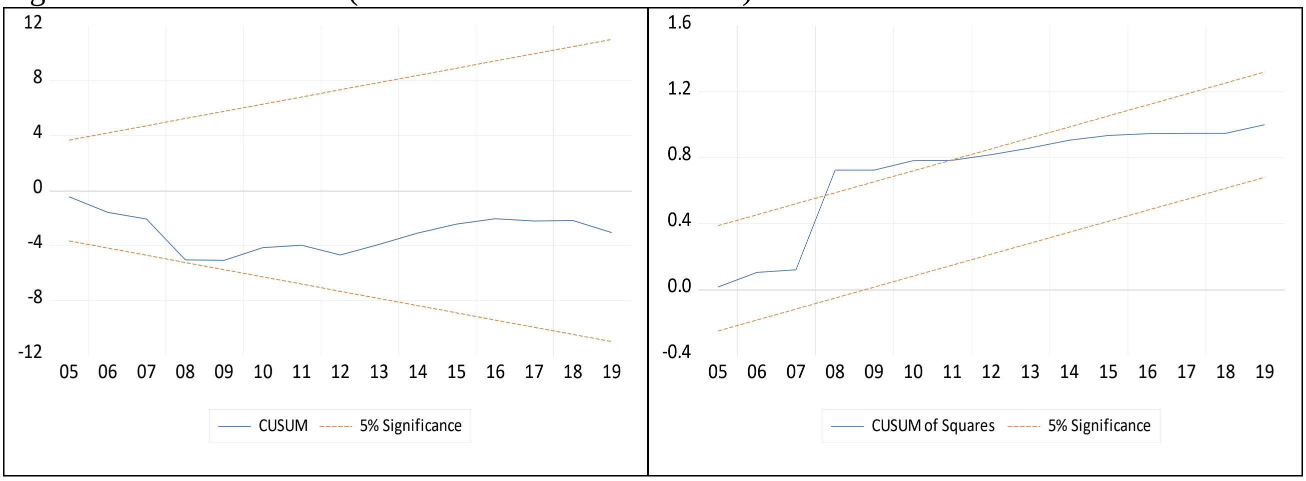
[15] The null hypothesis of existence of diagnostics abnormality (existence of serial correlation, non-normal distribution of series, heteroskedasticity, functional misspecification and parameter instability) can be rejected when the p-value is low (< 0.05). see section 4.2.4.4 for residual diagnostic tests and hypotheses.

Figure 5-5: CUSUM Plots (LNFDI = LNGDP + LNINFR)



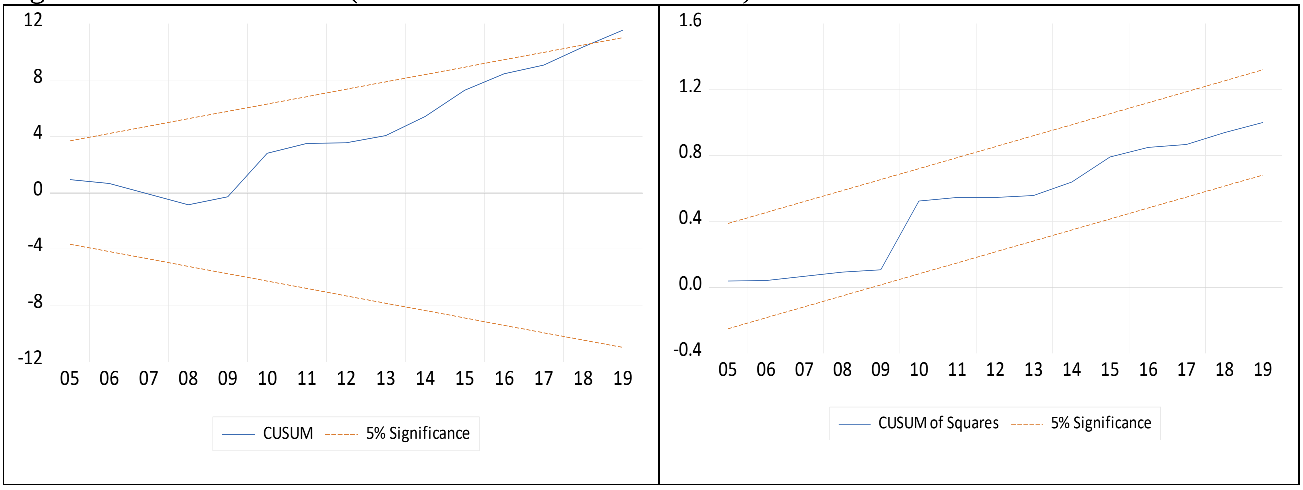
The CUSUM and CUSUM of squares plots lie within the 5 per cent significant level boundary, therefore, there is parameter stability in the regression model where LNFDI is the regressand and LNGDP, LNINFR and control variables are the explanatory variables.

Figure 5-6: CUSUM Plots (LNGDP = LNFDI + LNINFR)



The above figure shows that CUSUM and CUSUM of squares plots are largely within the 5 per cent significance boundary. Therefore, there is parameter stability in the model.

Figure 5-7: CUSUM Plots (LNINFR = LNFDI + LNGDP)



The CUSUM plots (5-5 to 5-7) show parameter stability as the plots do not adversely deviate from the 5 per cent significance level boundary. This done, the ARDL bounds cointegration tests are conducted, and the findings are presented in Table 5-13.

Table 5-13: ARDL Bounds Cointegration Test Results (Dependent Variables: LNFDI, LNGDP and LNINFR)

Equation	Dependent Variable	Independent Variables	Long-Run Relationship		F-statistic	t-statistic
			Coefficients	P-Value		
1.	LNFDI	LNGDP	-0.291307	0.3377	12.899922***	-6.163532***
		LNINFR	4.221877***	0.0000		
2.	LNGDP	LNFDI	-0.006026	0.7519	13.34664***	-5.922322***
		LNINFR	0.038730	0.8803		
3.	LNINFR	LNFDI	0.057512	0.1979	2.797323	-2.850483
		LNGDP	-0.051248	0.7180		

(*) Significant at 10 per cent, (**) Significant at 5 per cent, and (***) Significant at 1 per cent. Low p-values (< 0.10) indicate the significance of the effect of the independent variable on the regressand in the long-run. Significance of the F-statistic and t-statistic based on upper and lower bounds critical values given by Pesaran et al 2001 (see Table 5-9)[16].

The ARDL bounds cointegration test in the equation consisting of LNFDI, LNGDP and LNINFR presented in Table 5-13 reveals no cointegration in equation 3 where LNINFR is the dependent variable and cointegration exists in equations 1 and 2 where LNFDI and LNGDP are

[16] Raw analysis outputs from Eviews are presented in the Appendix. The analysis results are compared with the upper and lower bound statistics from Pesaran, *et al* (2001). Please see the methodology section 4.5.1.1 and figure 4-1, empirical results section 5.3.2 and Table 5-9. This explains the way cointegration is determined to exist or not.

the regressands, respectively. The detailed analyses are presented in Appendix 2 (c), Appendix 2 (f) and Appendix 2 (i) for the cointegration test results.

In the equation where LNFDI is the dependent variable, the overall F-statistic of 12.90, which is above the upper bound critical value of 6.36 at the 1 per cent significance level, is obtained. The obtained absolute t-statistic value of -6.16 is above the upper bound critical value of -4.1 at the 1 per cent significance level. In the equation where the dependent variable is LNGDP, the cointegration test results produce the overall F-statistic (13.35) from the F-Bounds test and the t-statistic (-5.92) from the t-Bounds test, both of which are above the respective upper bounds critical values (6.36 and -4.1, respectively). The two cointegration test results are statistically significant at the 1 per cent significance level.

In the LNINFR dependent variable equation, the overall F-statistic (2.80) is less than the lower bound critical value (3.17) at the 10 per cent level, while the t-statistic (-2.85) is between the upper (-3.21) and lower bound critical values (-2.57) at the 10 per cent significance level. Therefore, the hypothesis of no cointegration cannot be rejected at the 5 per cent significance level in the equation where LNINFR is the dependent variable.

Concerning the long-run relationship among the variables, in the equation where LNFDI is the dependent variable, infrastructure development (LNINFR) has a positive and statistically significant long-run impact on FDI. The result suggests that a one per cent rise in infrastructure development may lead to a 4.22 per cent jump in FDIs. However, economic growth (LNGDP) has a negative and statistically insignificant long-run impact on FDI. When LNGDP is the dependent variable, FDI and infrastructure have statistically insignificant (at the 5 per cent level) effects on economic growth. In the equation which has LNINFR as the dependent variable, FDI and economic growth have statistically insignificant effects.

The long-run models for the above equations are presented next:

$$LNFDI_t = -0.2913^{*}LNGDP_t + 4.2219^{*}LNINFR_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (35)$$

$$LNGDP_t = -0.0060^{*}LNFDI_t + 0.0387^{*}LNINFR_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (36)$$

$$LNINFR_t = 0.0575^{*}LNFDI_t - 0.0512^{*}LNGDP_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (37)$$

The next stage of the analysis is to investigate the error correction regression in the equations where cointegration has been determined to exist (where LNFDI and LNGDP are the dependent variables), and short-run regression of equation where no cointegration exists (where LNINFR is the dependent variable). The outputs are presented in Table 5-14 next.

Table 5-14: Error Correction/Short-run Regression (Dependent variables: D(LNFDI), D(LNGDP) and D(LNINFR))

	Equation 1	Equation 2	Equation 3
Output Variable	D(LNFDI)	D(LNGDP)	D(LNINFR)
Regressors			
D(LNFDI)	-	-	-0.001644 (0.8863)
D(LNFDI(-1))	0.883518*** (0.0024)	-	0.015058 (0.3128)
D(LNFDI(-2))	0.262945 (0.1153)	-	-0.002216 (0.8799)
D(LNFDI(-3))	-	-	0.006183 (0.5836)
D(LNGDP)	-	-	0.012589 (0.7845)
D(LNGDP(-1))	-	0.611241*** (0.0009)	-0.022271 (0.6312)
D(LNGDP(-2))	-	0.395096*** (0.0037)	0.105629** (0.0114)
D(LNGDP(-3))	-	0.193838** (0.0103)	-0.022286 (0.3290)
D(LNINFR)	-0.148969 (0.9443)	-	-
D(LNINFR(-1))	6.809679*** (0.0094)	-	-0.239369 (0.2268)
D(LNINFR(-2))	-3.717852 (0.0689)	-	-0.304963 0.0769)
D(LNINFR(-3))	-	-	-0.080472 (0.6577)
LNOPN	4.553645*** (0.0006)	0.380836 (0.0753)	0.184747 0.1063)
LNINFL	-0.158061	-0.115409**	-0.018145

	(0.5129)	(0.0244)	(0.4234)
LNEXC	-1.357449*** (0.0011)	-0.256912*** (0.0022)	-0.031920 (0.2575)
LNCRD	0.323876 (0.8483)	-0.414094 (0.1815)	-0.167030 (0.2134)
LNLAB	-2.620241*** (0.0053)	0.337745** (0.0377)	0.062056 (0.3381)
DUM	-0.527423 (0.4653)	0.200246 (0.1721)	0.019227 (0.7520)
C	36.56118 (0.0001)	1.428874 (0.3169)	0.049233 (0.9345)
ECT(-1)	-2.463030*** (0.0000)	-1.457948*** (0.0000)	-
Diagnostics			
Breusch-Godfrey LM	0.700032 (0.5045)	0.133834 (0.8752)	6.059815 (0.1069)
Breusch-Pagan-Godfrey	1.077092 (0.4121)	0.601228 (0.8253)	0.963946 (0.5190)
Ramsey RESET	8.015324 (0.2081)	0.328480 (0.5706)	0.019186 (0.8909)

*The First line contains estimated coefficients, in parenthesis () are the probability values. Emphasis is placed on *** p<0.01 (Significant at 1 per cent level), and ** p<0.05 (Significant at 5 per cent level).*

The long-run relationship between LNFDI, LNGDP and LNINFR is depicted by the significance of ECT (error correction term). Aregbeshola (2014) asserts that in the error correction estimation, error terms having coefficients that are negative attain future equilibrium via positive response patterns, whereas error terms that have coefficients that are positive mean-revert via negative future trends. But in all cases, the error terms are relevant only when they are statistically significant.

As shown in Table 5-14, the ECT is negative in equations 1 and 2 where cointegration was determined to exist. In the D(LNFDI) dependent variable equation, the ECT is -2.46 and significant at the 1 per cent level (with p-value of 0.0000 < 0.01). The reversion to the equilibrium, in the long-run, is at an adjustment speed of 246 per cent. The speed of adjustment, in this case, is positive and rapid. In the short-run, the one-period lag of FDI, one-period lag of infrastructure, and market openness have positive and significant effects on FDI. A one per cent rise in LNFDI(-1), LNINFR(-2) and LNOPN lead to 0.88 per cent, 6.81 per cent and 4.55 per cent rise, respectively, in FDI in the short-run. The exchange rate and the labour force have a statistically significant negative effect on FDI in the short-run. A one per cent rise in the exchange rate and the labour force leads to 1.36 per cent and 2.62 per cent decrease in FDI, respectively.

When the equation is run with economic growth (D(LNGDP)) as the regressand, the error term (ECT(-1)) is negative (-1.46) and is significant at the 1 per cent level (p-value is 0.0000 < 0.01). In this equation, the reversion to long-run equilibrium after a short-run shock is at an adjustment speed of 146 per cent. The one-period lag of economic growth (p-value 0.0009, coefficient 0.6112), two-period lag of economic growth (p-value 0.0037, coefficient 0.3951), three-period lag of economic growth (p-value 0.0103, coefficient 0.1938) and labour (p-value 0.0377, coefficient 0.3377) all have short-run positive causal effects on economic growth (dependent variable). This suggests that a 1 per cent increase in the one-period lag of economic growth may cause economic growth to increase by 0.61 per cent in the short-run. A 1 per cent increase in the two-period and the three-period lags of economic growth may result in 0.40 per cent and 0.19 per cent rise in economic growth, respectively. Furthermore, a 1 per cent increase in labour resources may result in 0.34 per cent rise in economic growth. The inflation rate and the exchange rate have negative impacts on economic growth that are significant at the 5 per cent significance level. A 1 per cent rise in the inflation rate, and exchange rate leads to 0.12 per cent and 0.26 per cent decrease in the rate of economic growth, respectively.

In the equation where D(LNINFR) is the dependent variable, the lack of determination of the existence of cointegration led to the estimation of a short-run regression. The short-run regression results demonstrate that infrastructure development is positively affected by the two-period lag of economic growth (p-value 0.0114, coefficient 0.1056). A 1 per cent shift in the one-period lag of economic growth may lead to a 0.11 per cent change in the same direction in infrastructure development.

Three diagnostic tests are undertaken to confirm that the estimates from the error correction regression are consistent, and statistically valid inferences can be made from them. The tests include the no residual correlation test done using Breusch-Godfrey LM (Lagrange multiplier) test, heteroskedasticity test done using Breusch-Pagan-Godfrey test and no functional mis-specification test done using Ramsey RESET test. All the diagnostics are satisfactory at 5 per cent significance level (p-values > 0.05) as shown in Table 5-14 above.

The ARDL bounds test approach and VECM method determine whether any long-run co-relation exists among the study variables. However, it does not give the direction of causality. The multivariate Granger-causality test is performed next because cointegration was confirmed to exist between LNFDI, LNGDP and LNINFR.

Table 5-15: Granger Causality Test (Endogenous variables: LNFDI, LNGDP, LNINFR)

Null Hypothesis	F-Statistic
LNGDP does not Granger Cause LNFDI	0.65189 (0.5864)
LNFDI does not Granger Cause LNGDP	1.34987 (0.2719)
LNINFR does not Granger Cause LNFDI*	2.37219 (0.0847)
LNFDI does not Granger Cause LNINFR*	2.47147 (0.0757)
LNINFR does not Granger Cause LNGDP	1.70763 (0.1808)
LNGDP does not Granger Cause LNINFR	0.22848 (0.8760)

*Parenthesis () contains the probability values of the F-statistic. Emphasis is placed on *** p<0.01 (Significant at 1 percent level), ** p<0.05 (Significant at 5 percent level) and * p<0.10 (Significant at 10 percent level).*

The rejection of the null hypothesis that LNINFR does not Granger cause LNFDI is done at the 10 per cent significance level. There is also the rejection at the 10 per cent significance level of the null hypotheses that LNFDI does not Granger cause LNINFR. Therefore, the Granger causality runs two-way from LNINFR to LNFDI. A bi-directional causality runs from infrastructure development to FDI. Therefore, the Granger causality outcomes from the analysis are as follows:

- Infrastructure Granger causes FDI.
- FDI Granger causes infrastructure development.

5.3.2.2 Relationship Between LNFDI, LNGDP and LNENEI

The regression analysis between FDI, economic growth and energy infrastructure (ENEI) are presented next.

Table 5-16: ARDL Model Regression (LNFDI, LNGDP, and LNENEI)

	Equation 4	Equation 5	Equation 6
Output Variable	LNFDI	LNGDP	LNENEI
Selected Model	(1,0,0)	(4,0,0)	(2, 0, 0)
Regressors			
LNFDI	-	-0.004412 (0.8731)	-0.013288 (0.1820)
LNFDI(-1)	-0.227592 (0.1604)	-	-
LNGDP	-0.117000 (0.8700)	-	0.011577 (0.8066)
LNGDP(-1)	-	0.139759 (0.3567)	-
LNGDP(-2)	-	-0.235400 (0.1260)	-
LNGDP(-3)	-	-0.192191 (0.1090)	-
LNGDP(-4)	-	-0.193086** (0.0124)	-
LNENEI	-2.315073 (0.2812)	0.302848 (0.4550)	-
LNENEI(-1)	-	-	0.348353** (0.0289)
LNENEI(-2)	-	-	0.192411 (0.1497)
LNOPN	3.563473*** (0.0101)	0.448255 (0.0745)	0.062183 (0.5439)
LNINFL	0.172052 (0.6027)	-0.124262** (0.0214)	0.035167 (0.0813)
LNEXC	-0.819165 (0.1509)	-0.321625*** (0.0064)	0.027517 (0.5255)
LNCRD	-0.024254 (0.9901)	-0.511060 (0.1386)	0.211444 (0.0806)
LNLAB	3.769387 (0.0234)	0.189268 (0.5347)	0.361280*** (0.0004)
DUM	-1.557703 (0.0871)	0.217210 (0.1645)	-0.112882 (0.0497)

Constant	-29.73541 (0.0158)	2.100516 (0.3171)	-2.536961 (0.0004)
Adjusted R^2	0.205149	0.539890	0.992211
DW statistic	2.185272	2.130170	2.135121
F-statistic	2.376522** (0.0299)	5.400232*** (0.0000)	471.3262*** (0.0000)

*The first line contains estimated coefficients. In parenthesis () are the probability values (p-values). Emphasis is placed on *** p<0.01 (Significant at 1 per cent level) and ** p<0.05 (Significant at 5 per cent level). Each term's p-value tests the null hypothesis of no effect from the respective independent variable on the regressand (that coefficient is equal to zero). Therefore, the null hypothesis can be rejected when the p-value is low (< 0.05). DW is the Durbin-Watson statistic.*

The optimal lag lengths are (1, 0, 0), (4, 0, 0) and (2, 0, 0) for the equations where LNFDI, LNGDP and LNENEI are the dependent variables, respectively. The deterministic trends have not been included as fixed regressors in all the equations since they are statistically insignificant at the 5 per cent level. The explanatory variables explain 20.5 per cent, 54.0 per cent and 99.2 per cent of the changes shown by the dependent variables in the three equations as indicated by their respective Adjusted R^2 statistics. The F-statistics have probability values that are < 0.05, implying that at least one of the independent variables accounts for the changes in the dependent variable in each equation.

The Durbin-Watson (D) statistics in the three equations (2.185272, 2.130170 and 2.135121, respectively) are all greater than the upper bound value (D_U) of 1.98597 (i.e., $D > D_U$) for a sample size of 50 observations (1970-2019) and ten number of terms (including the intercept and the dummy variable). Therefore, a conclusion can safely be made that there is no autocorrelation in the errors of the three regression models.

The null hypothesis of no effect of the regressor on the dependent variable is rejected when the p-value is low (< 0.05). The one-period lag of energy infrastructure (p-value - 0.0289, coefficient - 0.348353) positively influences the current rate of energy infrastructure investment. The market openness (p-value - 0.0101, coefficient - 3.563473) has a statistically significant positive effect on FDI. The rate of inflation (p-value - 0.0214, coefficient -0.124262) has a statistically significant negative effect on economic growth. The exchange rate (p-value - 0.0064, coefficient -0.321625) has a statistically significant negative effect on economic growth, while labour (p-value - 0.0004, coefficient 0.361280) has a statistically significant positive effect on energy infrastructure development.

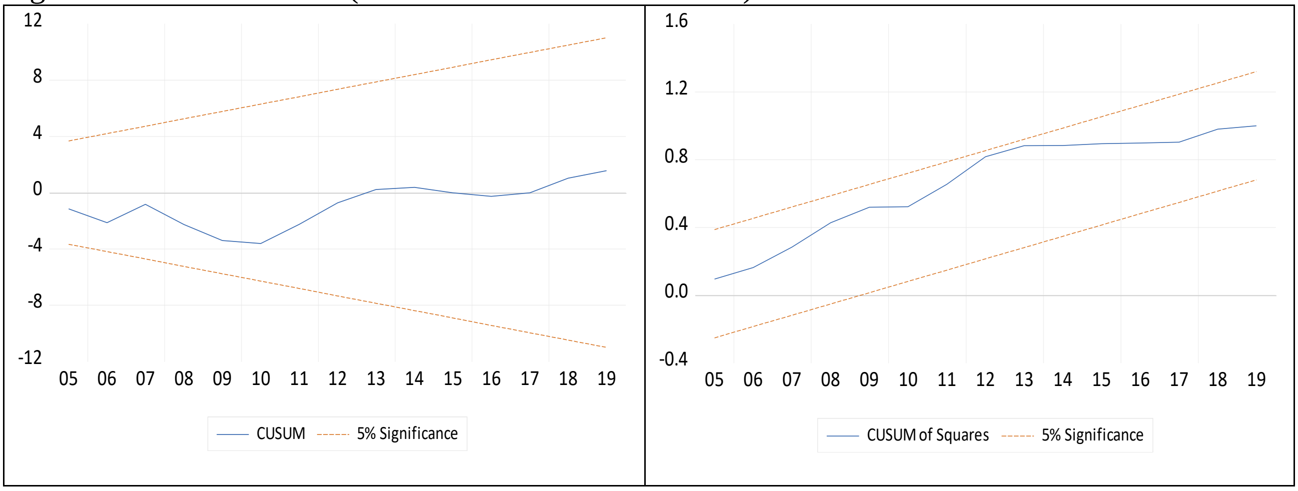
Table 5-17: Diagnostic Tests – Analysis of Infrastructure Sub-Sectors (Dependent Variables: LNFDI and LNGDP)

Equation	Dependent Variable	Independent Variables	Ramsey RESET	Jarque-Bera Statistic	Breusch-Godfrey LM	Breusch-Pagan-Godfrey
4.	LNFDI	LNGDP LNENEI LNOPN LNINFL LNEXC LNCRD LNLAB	0.0027 (0.9592)	22.1763*** (0.0000)	2.7737 (0.0754)	1.1784 (0.3355)
5.	LNGDP	LNFDI LNENEI LNOPN LNINFL LNEXC LNCRD LNLAB	0.5537 (0.4623)	3.5651 (0.1682)	0.3523 (0.7058)	0.5773 (0.8444)
6.	LNENEI	LNFDI LNGDP LNOPN LNINFL LNEXC LNCRD LNLAB	0.0704 (0.7922)	3.5982 (0.1654)	0.7038 (0.5016)	0.9427 (0.5070)

*The F statistics on the first line, probability values in parenthesis (). (**) Significant at 5 per cent, and (***) Significant at 1 per cent. {Emphasis is placed on *** p<0.01 (1%), ** p<0.05 (5%)}. Low p-values (< 0.05) indicate the existence of diagnostic abnormality, and the null hypothesis cannot be rejected.*

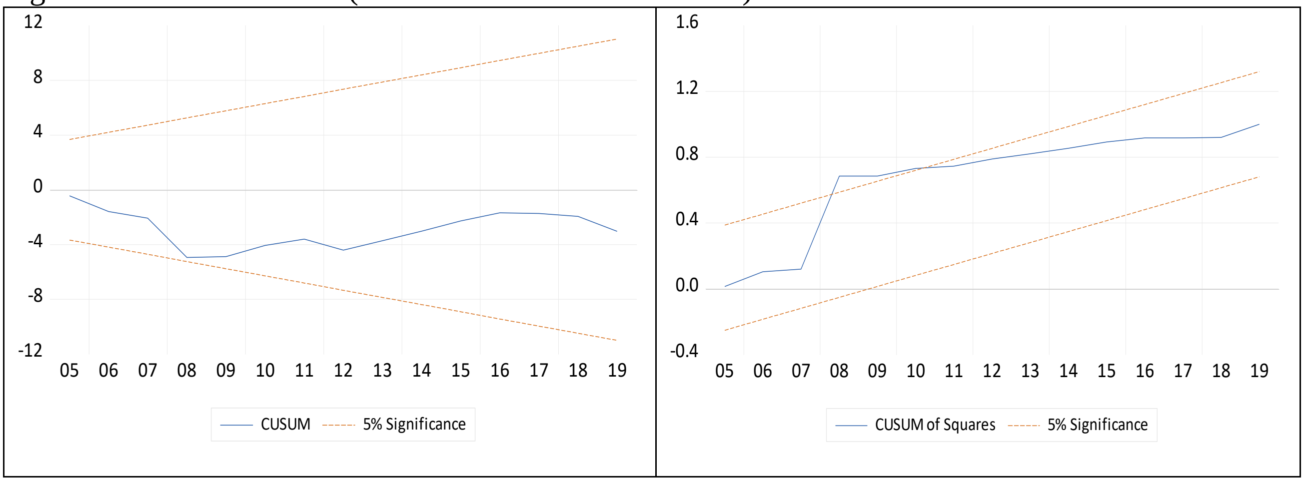
The Jarque-Bera normality test has a failure in the equation where LNFDI is the dependent variable (equation 4). The p-values are 0.0000 (<0.01). This means that the data is not from a population with normal distribution. A failure in the normality test does not lend the obtained estimates inconsistent and inference can be made from them (Wooldridge, 2016), especially in the face of stable CUSUM and CUSUM of squares. All the other diagnostics of the three equations are satisfactory at the 5 per cent significance level. Generally, the respective diagnostic null hypotheses cannot be rejected, indicating that all the residuals have no serial correlation, have constant variance (homoscedasticity), and no model misspecification. Most of the residuals are normally distributed.

Figure 5-8: CUSUM Plots (LNFDI = LNGDP + LNENEI)



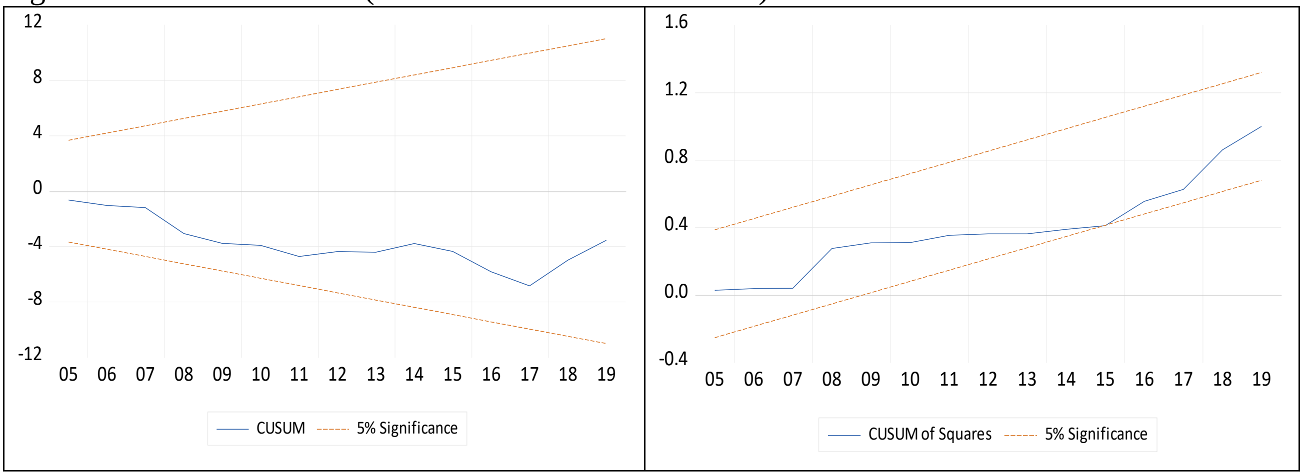
The preceding figure shows the CUSUM and CUSUM of Squares plots lie within the 5 per cent significance level boundary in the equation where FDI is the regressand and economic growth, energy infrastructure and the control variables are the explanatory variables.

Figure 5-9: CUSUM Plots (LNGDP = LNFDI + LNENEI)



The CUSUM and CUSUM of Squares plots lie within the 5 per cent significance level boundary in the equation where economic growth is the regressand and FDI, energy infrastructure and the control variables are the explanatory variables.

Figure 5-10: CUSUM Plots (LNENEI = LNFDI + LNGDP)



The CUSUM and CUSUM of Squares plots lie within the 5 per cent significance level boundary in the regression analysis where energy infrastructure is the dependent variable, and FDI and economic growth are some of the explanatory variables. The CUSUM plots lie largely within the 5 per cent significance level boundary, as shown in figures 5-8 to 5-10 above. Therefore, there is significant parameter constancy and no detected systematic alteration in the coefficients (model stability) in all the regression analyses (equations 4, 5 and 6).

The cointegration test results for the relationship between LNFDI, LNGDP and LNENEI are displayed in Table 5-18.

Table 5-18: ARDL Bounds Cointegration Tests (Analysis of Infrastructure Sub-Sectors)

Equation	Dependent Variable	Independent Variables	Long-Run Relationship		F-statistic	t-statistic
			Coefficients	Probability		
4.	LNFDI	LNENEI	-1.885865	0.2862	20.54022***	-7.717582***
		LNGDP	-0.095308	0.8703		
5.	LNGDP	LNENEI	0.204500	0.4549	13.75075***	-6.411354***
		LNFDI	-0.002979	0.8730		
6.	LNENEI	LNFDI	-0.028935	0.2174	4.863706**	-3.921712**
		LNGDP	0.025209	0.8066		

(***) Significant at 1 per cent, (**) Significant at 5 per cent, and (*) Significant at 10 per cent. P-values are in parentheses (). Low p-values (< 0.10) indicate the significance of the effect of the independent variable on the regressand in the long-run. The significance of the F-statistic and t-statistic is based on upper and lower bounds critical values given by Pesaran et al. 2001 (see Table 5-9).

In the case where LNFDI is the dependent variable, the F-bounds test produces the F-statistic (20.54) that is larger than the upper critical value (6.36) at the 1 per cent significance level. The t-bounds test also produces a t-statistic (-7.72) that is above the upper bound critical value (-4.1) at the 1 per cent significance level (see Appendix 2 (n)). The null hypothesis of no cointegration is therefore rejected. The findings further indicate that economic growth (LNGDP) and energy infrastructure (LNENEI) both have insignificant long-run causal effects on foreign direct investment (LNFDI).

In the equation where LNGDP is the regressand, both the overall F-statistic (13.75) and t-statistic (- 6.41) are larger than the upper critical values (6.36 and -4.1, respectively) at the 1 per cent significance level (see Appendix 2 (q)). As a result, the null hypothesis that there is no cointegration is rejected. The cointegration test outcomes for the case where LNENEI is the dependent variable and LNFDI and LNGDP are the dependent variables (see Appendix 2 (t)), show the overall F-statistic (4.86) to be higher than the upper bounds critical value (4.85) at 5 per cent significance level. Likewise, the t-statistic (-3.92) value is also higher than the upper bounds critical value (-3.53) at the 5 per cent significance level. Therefore, the null hypothesis of no levels relationship (no cointegration) in the equation is rejected. The findings, therefore, indicate the existence of cointegration between FDI, economic growth and energy infrastructure when energy infrastructure is the regressand. Both FDI (p-value 0.2174) and economic growth (p-value 0.8066) do not significantly influence energy infrastructure in the long-run.

The long-run models for the three equations are written as follows:

$$LNFDI_t = -0.0953^{*}LNGDP_t - 1.8859^{*}LNENEI_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (38)$$

$$LNGDP_t = -0.0030^{*}LNFDI_t + 0.2704^{*}LNENEI_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (39)$$

$$LNENEI_t = -0.0289^{*}LNFDI_t + 0.0252^{*}LNGDP_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (40)$$

Based on the cointegration test outcomes, the study proceeds to undertake error correction regression for equations 4, 5 and 6. The analysis outcomes are shown in Table 5-19.

Table 5-19: Error Correction Regression (D(LNFDI), D(LNGDP) and D(LNENEI))

	Equation 4	Equation 5	Equation 6
Output Variable	D(LNFDI)	D(LNGDP)	D(LNENEI)
Selected Model	(1,0,0)	(4,0,0)	(1,0,0)
Regressors			
D(LNGDP(-1))	-	0.620677*** (0.0007)	-
D(LNGDP(-2))	-	0.385277*** (0.0039)	-
D(LNGDP(-3))	-	0.193086*** (0.0098)	-
D(LNENEI(-1))	-	-	-0.192411 (0.1308)
LNOPN	3.563473*** (0.0037)	0.448255** (0.0381)	0.062183 (0.4541)
LNINFL	0.172052 (0.4996)	-0.124262** (0.0147)	0.035167** (0.0371)
LNEXC	-0.819165** (0.0300)	-0.321625*** (0.0005)	0.027517 (0.4414)
LNCRD	-0.024254 (0.9889)	-0.511060 (0.0975)	0.211444 (0.0651)
LNLAB	3.769387***	0.189268	0.361280***

	(0.0001)	(0.2097)	(0.0002)
DUM	-1.557703 (0.0638)	0.217210 (0.1370)	-0.112882 (0.0330)
C	-29.73541 (0.0004)	2.100516 (0.1384)	-2.536961 (0.0002)
ECT(-1)	-1.227592*** (0.0000)	-1.480917*** (0.0000)	-0.459235*** (0.0004)
Diagnostics			
Breusch-Godfrey LM	2.773677 (0.0754)	0.352306 (0.7058)	0.703779 (0.5016)
Breusch-Pagan-Godfrey	1.178426 (0.3355)	0.577270 (0.8444)	0.942718 (0.5070)
Ramsey RESET	0.002653 (0.9592)	0.744076 (0.4623)	0.070418 (0.7922)

*The First line contains estimated coefficients, in parenthesis () are the probability values. Emphasis is placed on *** p<0.01 (Significant at 1 per cent level) and ** p<0.05 (Significant at 5 per cent level).*

The significance of the ECT depicts the existence of a long-run relationship between the variables of the study. As shown in Table 5-19, in the equations involving LNFDI, LNGDP and LNENEI, the ECTs are negative (-1.22, -1.48 and -0.45) and significant at the 1 per cent significance level as shown by the probability values (0.0000 < 0.01). The reversion to the long-run equilibrium after a shock in the short-run is at an adjustment speed of 122 per cent when FDI is the dependent variable, 148 per cent when GDP is the dependent variable and 45.9 per cent when ENEI is the dependent variable. When either FDI or GDP is the dependent variable, the speed of adjustment is rapid. In the short-run, the past performance of the economy has a significant positive impact on the future performance of the economy. A 1 per cent change in one-period lag, two-period lag, and three-period lag of economic growth have 0.62 per cent, 0.38 per cent and 0.19 per cent change in the same direction in economic growth. The three effects are statistically significant at the 1 per cent significance level. The findings further show that FDI and economic growth have no short-run impact on energy infrastructure. Both explanatory variables have p-values > 0.10, implying that the variables are statistically insignificant in influencing energy infrastructure. Similarly, both economic growth and energy infrastructure development do not have a short-run effect on FDI.

The market openness has a statistically significant positive effect on FDI and economic growth in the short-run. The effect of market openness on FDI and economic growth are significant at 1 per cent and 5 per cent significance levels. A 1 per cent increase in market openness causes FDI to increase by 3.56 per cent and economic growth to increase by 0.45 per cent. The rate of inflation negatively influences the rate of economic growth but has a positive effect on energy infrastructure investments. A 1 per cent rise in the rate of inflation causes economic growth to decrease by 0.12 per cent, and investments in energy infrastructure to increase by 0.04 per cent. The exchange rate has a statistically significant impact on FDI and economic growth, while labour resources positively influence FDI and the investment in energy infrastructure. Furthermore, a 1 per cent change in the exchange rate leads to 0.82 per cent and 0.32 per cent decrease in FDI and economic growth, respectively. A 1 per cent change in labour resources causes a change in the same direction in FDI and energy infrastructure investment of 3.77 per cent and 0.36 per cent, respectively. The effects of labour resources are statistically significant at the 1 per cent significance level.

Following the confirmation of the existence of cointegration and long-run relationship between LNFDI, LNGDP and LNTRAI, the Granger causality test is undertaken to establish the direction of causality, i.e., whether it is unidirectional, bidirectional or no causality exists.

Table 5-20: Granger Causality Test (Endogenous variables: LNFDI, LNGDP, LNENEI)

Null Hypothesis:	F-Statistic (Prob.)
LNGDP does not Granger Cause LNFDI	0.98265 (0.3267)
LNFDI does not Granger Cause LNGDP	1.89345 (0.1755)
LNENEI does not Granger Cause LNFDI	1.21709 (0.2757)
LNFDI does not Granger Cause LNENEI**	5.34870 (0.0253)
LNENEI does not Granger Cause LNGDP	0.18843 (0.6663)
LNGDP does not Granger Cause LNENEI	0.00815 (0.9284)

*Parenthesis () contains the probability values of the F-statistic. Emphasis is placed on *** p<0.01 (Significant at 1 percent level), ** p<0.05 (Significant at 5 percent level) and * p<0.10 (Significant at 10 percent level).*

The outcomes result in the rejection of the null hypothesis: LNFDI does not Granger cause LNENEI (at 5 per cent significance level). Therefore, FDI Granger causes infrastructure development. There is one-way causality from FDI to infrastructure development (energy infrastructure).

5.3.2.3 Relationship between LNFDI, LNGDP and LNTRAI

Table 5-21: ARDL Model Regression (LNFDI, LNGDP and LNTRAI)

	Equation 7	Equation 8	Equation 9
Output Variable	LNFDI	LNGDP	LNTRAI
Selected Model	(2,0,2)	(2,2,3)	(3,0,0)
Regressors			
LNFDI	-	-5.79E-05 (0.9986)	-0.007527 (0.2627)
LNFDI(-1)	-0.412679** (0.0263)	-0.013675 (0.7195)	-
LNFDI(-2)	-0.307303 (0.0758)	-	-
LNGDP	-0.105075 (0.8887)	-0.058079 (0.1079)	0.061912 (0.0856)
LNGDP(-1)	-	0.188370 (0.2317)	-
LNGDP(-2)	-	-0.165418 (0.2091)	-
LNTRAI	-2.648793 (0.4672)	1.359508 (0.0846)	-
LNTRAI(-1)	2.376074 (0.6280)	-1.511975 (0.1404)	0.892936*** (0.0000)
LNTRAI(-2)	6.694906 (0.1877)	-0.896888 (0.4163)	0.435748** (0.0422)
LNTRAI(-3)	-	1.770727** (0.0417)	-0.428173** (0.0184)
LNOPN	7.369944***	0.637351	0.015230

	(0.0002)	(0.1675)	(0.8426)
LNINFL	0.003055 (0.9928)	-0.144297** (0.0221)	0.001010 (0.9396)
LNEXC	-3.246796*** (0.0009)	-0.384255 (0.1129)	-0.023092 (0.5455)
LNCRD	1.159283 (0.5521)	-0.053069 (0.8944)	0.011670 (0.8786)
LNLAB	0.221766 (0.8680)	-0.060849 (0.8246)	0.096839 (0.0958)
DUM	-0.935557 (0.2917)	0.249343 (0.1596)	-0.037052 (0.3305)
Constant	-46.52295 (0.0019)	-1.098188 (0.7510)	-0.471257 (0.3971)
Adjusted R^2	0.279471	0.458657	0.990870
DW statistic	2.372768	2.220771	2.067185
F-statistic	2.519158** (0.0165)	3.598252*** (0.0013)	345.3085*** (0.0000)

*The first line contains estimated coefficients, in parenthesis () are the probability values (p-values). Emphasis is placed on *** p<0.01 (Significant at 1 per cent level) and ** p<0.05 (Significant at 5 per cent level). Each term's p-value tests the null hypothesis of no effect from the respective independent variable on the regressand (that coefficient is equal to zero). Therefore, the null hypothesis can be rejected when the p-value is low (< 0.05). DW is the Durbin-Watson statistic.*

The selected lag lengths are (2, 0, 2), (2, 2, 3) and (3, 0, 0) for the equations where LNFDI, LNGDP and LNTRAI are the dependent variables, respectively. The deterministic trend was statistically insignificant in the three equations and therefore was excluded in the regression analysis. The adjusted R-squared statistic was 27.9 per cent for the LNFDI dependent variable equation, 45.9 per cent for the LNGDP dependent variable equation and 99.1 per cent for the LNTRAI dependent variable equation.

The model overall F-statistics are all significant at the 5 per cent level (p-values are 0.0165, 0.0013 and 0.0000), indicating that at least one explanatory variable in every equation account for the variations in the respective dependent variable.

All the Durbin-Watson statistics in equations 7, 8 and 9 were greater than 1.98597 (upper bound critical value), i.e., $D > D_U$ for a sample of 50 observations and 10 regressors including the intercept. Therefore, there is no autocorrelation in the errors of the models.

The null hypothesis of no effect of the explanatory variable on the regressand can be rejected when the p-value is low (< 0.05). The p-values from the regression of the above three equations represented in Table 5-21 indicate that the one-period lag of FDI (p-value 0.0263, coefficient -0.4127) has a negative effect on the current FDI. The one-period lag (p-value 0.0000, coefficient 0.8929) and two-period lag (p-value 0.0422, coefficient 0.4357) of transport infrastructure have a positive effect on current transport infrastructure development. However, the three-period lag of transport infrastructure has a negative effect (p-value 0.0184, coefficient -0.4282) on current levels of transport infrastructure development, and a positive effect (p-value 0.0417, coefficient 1.7707) on economic growth. The market openness (p-value 0.0002, coefficient 7.3699) positively influences FDIs. The rate of inflation negatively influences (p-value 0.0221, coefficient -0.1443) economic growth, while the exchange rate has a negative effect (p-value 0.0009, coefficient -3.2468) on FDIs.

Table 5-22: Diagnostic Tests (LNFDI, LNGDP and LNTRAI)

Equation	Dependent Variable	Independent Variables	Ramsey RESET	Jarque-Bera Statistic	Breusch-Godfrey LM	Breusch-Pagan-Godfrey
7.	LNFDI	LNGDP LNTRAI LNOPN LNINFL LNEXC LNCRD LNLAB	4.5495** (0.0402)	7.5797 (0.0226)	2.6195 (0.0879)	1.1019 (0.3890)
8.	LNGDP	LNFDI LNTRAI LNOPN LNINFL LNEXC LNCRD LNLAB	0.9856 (0.3288)	5.1247 (0.0771)	0.5227 (0.5984)	0.8377 (0.6321)
9.	LNTRAI	LNFDI LNGDP LNOPN LNINFL LNEXC LNCRD LNLAB	5.3328** (0.0271)	3.8791 (0.1438)	1.4366 (0.2522)	0.9461 (0.5103)

*The F statistics on the first line, probability values in parenthesis (). (**)Significant at 5 per cent, and (***) Significant at 1 per cent. {Emphasis is placed on *** p<0.01 (1%), ** p<0.05 (5%)}. Low p-values (< 0.05) indicate the existence of diagnostic abnormality, and the null hypothesis cannot be rejected.*

The findings of diagnostic tests displayed in Table 5-22 reveal that at the 5 per cent significance level, most residuals obtained from the three ARDL model regressions are normally distributed (Jarque-Bera normality test), with no serial correlation (Breusch-Godfrey LM test) and homoscedastic (Breusch-Pagan-Godfrey heteroskedasticity test). However, the Ramsey RESET test has a failure in equations 7 and 9 where FDI and TRAI are the dependent variables, respectively. Despite the failure in the Ramsey RESET test, there is parameter stability in the models as shown by the CUSUM plots in figures 5-11 and 5-13. Therefore, inferences can be derived from the model findings.

Figure 5-11: CUSUM Plots (LNFDI = LNGDP + LNTRAI)

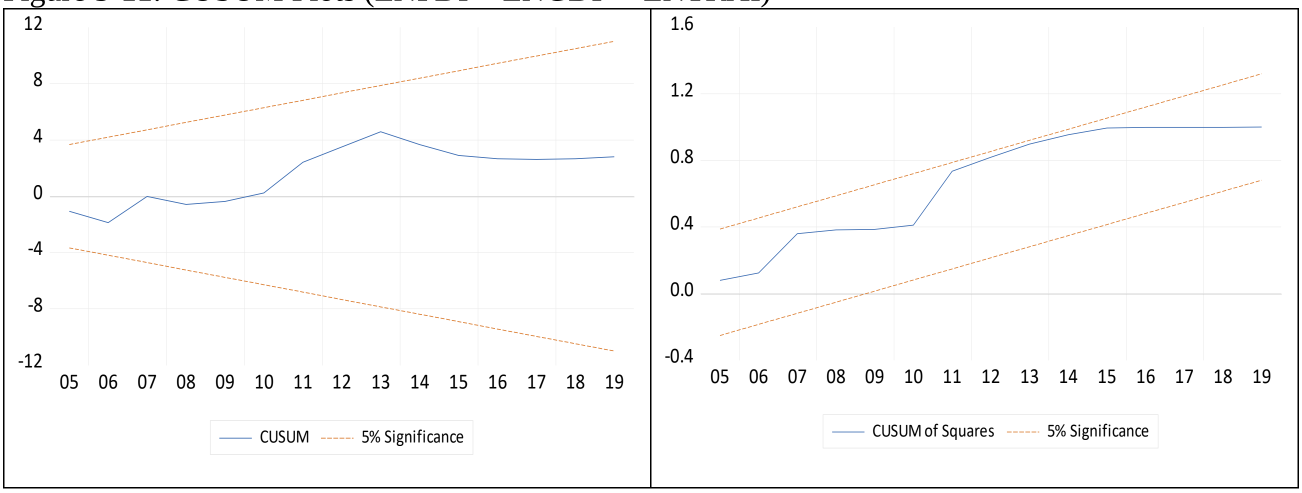


Figure 5-11 shows that the CUSUM plots mostly lie within the 5 per cent significance level boundary, implying that there is parameter stability in the equation.

Figure 5-12: CUSUM Plots (LNGDP = LNFDI + LNTRAI)

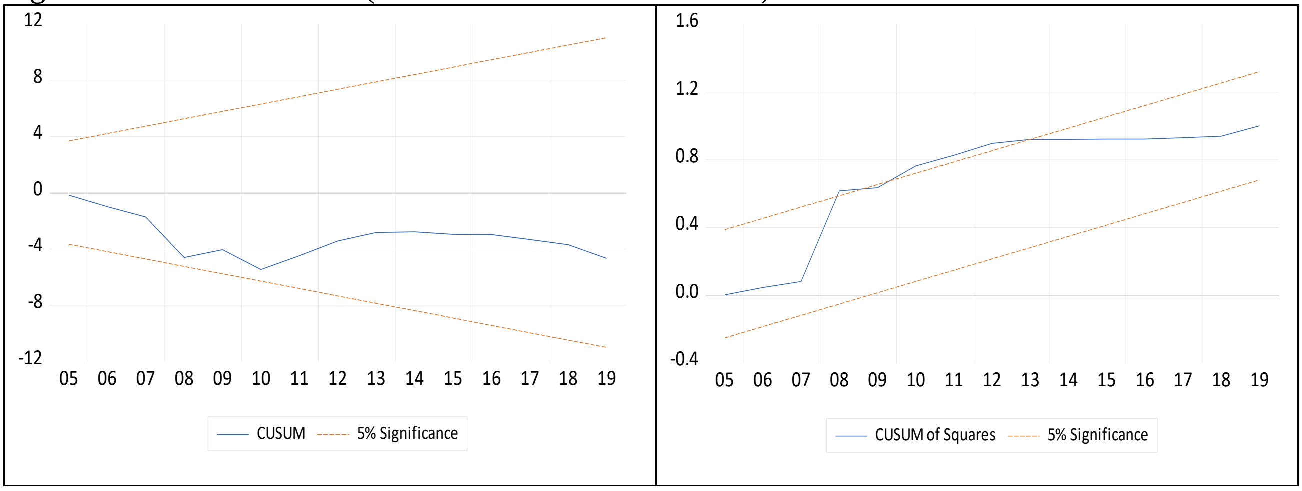
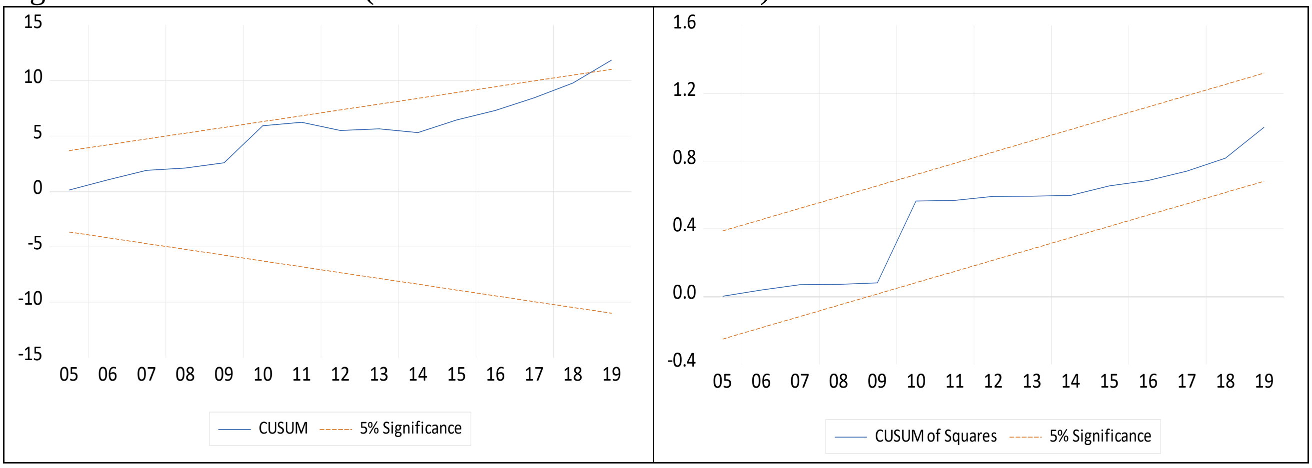


Figure 5-12 and Figure 5-13 show the CUSUM and CUSUM of Squares largely lie within the 5 per cent significance level boundary, implying that there is parameter stability in the two equations.

Figure 5-13: CUSUM Plots (LNTRAI = LNFDI + LNGDP)



The ARDL bounds cointegration test results are presented next.

Table 5-23: ARDL Bounds Cointegration Tests (LNFDI, LNGDP and LNTRAI)

Equation	Dependent Variable	Independent Variables	Long-Run Relationship		F-statistic	t-statistic
			Coefficients	Probability		
7.	LNFDI	LNTRAI	3.733869**	0.0171	14.17967***	-6.500648***
		LNGDP	-0.061091	0.8885		
8.	LNGDP	LNTRAI	0.738316	0.2780	14.25233***	-6.510749***
		LNFDI	-0.073498	0.3540		
9.	LNTRAI	LNFDI	-0.075656	0.5355	1.585284	-0.805690
		LNGDP	0.622304	0.4483		

(***) Significant at 1 per cent, (**) Significant at 5 per cent, and (*) Significant at 10 per cent. P-values are in parentheses (). Low p-values (< 0.10) indicate the significance of the effect of the independent variable on the regressand in the long-run. The significance of the F-statistic and t-statistic is based on upper and lower bounds critical values given by Pesaran et al. 2001 (see Table 5-9).

The ARDL bounds cointegration test in the equation consisting of LNFDI, LNGDP, and LNTRAI presented in Table 5-23 reveals cointegration in equations 7 and 8 and no cointegration where LNTRAI is the regressand in Equation 9. In the LNFDI dependent variable equation, the overall F-statistic (14.17) is greater than the upper bound critical value (6.36) at the 1 per cent level, while the t-statistic (-6.50) is greater than the upper bound critical value (-4.1) in absolute terms at the 1 per cent significance level. Therefore, the hypothesis of no cointegration is rejected at the 1 per cent significance level (see Appendix 2 (y)). The findings of the ARDL bounds cointegration results show that transport infrastructure has a significant effect (p-value 0.0170, coefficient 3.7339) on FDI.

In the equation where LNGDP is the regressand, the overall F-statistic (14.25) and the t-statistic (-6.51) are greater than the respective upper bounds critical values (6.36 and -4.1, respectively) at the 1 per cent significance level (see Appendix 2 (bb)). The null hypothesis of no cointegration is rejected. The long-run relationship results show that FDI and transport infrastructure do not statistically and significantly influence the rate of economic growth.

In the LNTRAI (dependent variable) equation, the F-statistic value (1.58) is evidently below the I (0) lower critical bound value (3.17) at the 10 per cent significance level. The t-statistic (-

0.81) is below the lower critical bound level (-2.57) at the 10 per cent significance level (see Appendix 2(ee)). The null hypothesis of no cointegration cannot be rejected, and hence FDI, economic growth and infrastructure development (transport) are not cointegrated when LNTRAI is the regressand.

When transport infrastructure is the output variable, there is no significant effect in the long-run from FDI and economic growth (all p-values > 0.10).

The long-run models are presented:

$$LNFDI_t = -0.0611^{*}LNGDP_t + 3.7339^{*}LNTRAI_t \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (41)$$

$$LNGDP_t = -0.07350^{*}LNFDI_t + 0.7383^{*}LNTRAI_t \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (42)$$

$$LNTRAI_t = -0.0757^{*}LNFDI_t + 0.6223^{*}LNGDP_t \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (43)$$

The findings of the ECM and the short-run model regressions involving the three variables (LNFDI, LNGDP and LNTRAI) are shown:

Table 5-24: ARDL Error Correction/Short-run Model Regression (D(LNFDI), D(LNGDP) and D(LNTRAI))

	Equation 7	Equation 8	Equation 8
Output Variable	D(LNFDI)	D(LNGDP)	D(LNTRAI)
Regressors			
D(LNFDI)	-	-5.79E-05 (0.9979)	-0.003666 (0.4929)
D(LNFDI(-1))	0.307303 (0.0626)	0.058079** (0.0231)	-0.001791 (0.7548)
D(LNGDP)	-	-	-0.013193 (0.6363)
D(LNGDP(-1))	-	0.165418 (0.1926)	0.001661 (0.9081)
D(LNTRAI)	-2.648793 (0.4450)	1.359508 (0.0739)	-
D(LNTRAI(-1))	-6.694906 (0.1110)	-0.873838 (0.2554)	-0.191984 (0.3110)
D(LNTRAI(-2))	-	-1.770727**	-

		(0.0173)	
LNOPN	7.369944*** (0.0000)	0.637351** (0.0145)	0.073157 (0.2041)
LNINFL	0.003055 (0.9912)	-0.144297** (0.0168)	-0.007976 (0.5858)
LNEXC	-3.246796*** (0.0000)	-0.384255*** (0.0008)	-0.069925*** (0.0010)
LNCRD	1.159283 (0.5358)	-0.053069 (0.8807)	-0.017853 (0.8367)
LNLAB	0.221766 (0.8007)	-0.060849 (0.7387)	0.087549** (0.0399)
DUM	-0.935557 (0.2429)	0.249343 (0.1297)	-0.011790 (0.7629)
Constant	-46.52295 (0.0001)	-1.098188 (0.5117)	-0.746221 (0.0591)
ECT (-1)	-1.719982*** (0.0000)	-0.977049*** (0.0000)	-
Diagnostics			
Breusch-Godfrey LM	2.6195 (0.0879)	0.9892 (0.5794)	3.115074 (0.0572)
Breusch-Pagan-Godfrey	1.1019 (0.3890)	0.2226 (0.9919	1.675942 (0.1192)
Ramsey RESET	4.5495 (0.4002)	0.0795 (0.8044)	4.104642 (0.0504)

*The First line contains estimated coefficients, in parenthesis () are the probability values. Emphasis is placed on *** p<0.01 (Significant at 1 per cent level) and ** p<0.05 (Significant at 5 per cent level).*

The error correction regression results are presented for the models where the existence of cointegration was established, that is for the equations where LNFDI and LNGDP are the output variables. In the equation where foreign direct investment (D(LNFDI)) is the regressand, the error term is rightly negative (-1.72) and statistically significant at the 1 per cent significance level (p-value 0.0000). This indicates a 172.0 per cent speed of adjustment back to the long-run equilibrium after a short-run shock. The market openness (p-value 0.0000, coefficient 7.3699 and the exchange rate (p-value 0.0000, coefficient -3.2468) have a statistically significant causal effect on FDI in the short-run. A 1 per cent rise in the market openness raises FDI by 7.37 per cent. A 1 per cent increase in the exchange rate causes FDI to decrease by 3.25 per cent.

In the LNGDP dependent variable equation, the error term is rightly negative (-0.977) and statistically significant at the 1 per cent significance level (p-value 0.0000). This indicates a

97.7 per cent speed of adjustment back to the long-run equilibrium after a short-run shock. The one-period lag of FDI has a positive effect (p-value 0.0231, coefficient 0.0581) on economic growth. The two-period lag of transport infrastructure has a statistically significant negative impact on economic growth. The impact is statistically significant at the 5 per cent significance level. A 1 per cent rise in the two-period lag of transport infrastructure development reduces economic growth by 1.77 per cent. The market openness (p-value 0.0145, coefficient 0.6374) positively influences economic growth. The rate of inflation (p-value 0.0168, coefficient -0.1443) negatively influences the rate of economic growth, while the exchange rate has a negative effect (p-value 0.0008, coefficient -0.3843) on economic growth.

The short-run regression of transport infrastructure as the regressand show no impact from FDI and economic growth. The exchange rate has in the short-run a negative impact on the development of transport infrastructure that is significant at 1 per cent significance level. A 1 per cent rise in the exchange rate causes transport infrastructure investment to decrease by 0.07 per cent. The labour resource has a statistically significant positive impact on transport infrastructure. A 1 per cent change in the labour resource cause investment in transport infrastructure to change in the same direction by 0.09 per cent.

The diagnostics are all satisfactory (p-values > 0.05). All three ARDL short-run models are well specified (Ramsey RESET functional form test), no serial correlation (Breusch-Godfrey LM test), and homoscedastic (Breusch-Pagan-Godfrey test).

Following the confirmation of the existence of cointegration and long-run relationship between LNFDI, LNGDP and LNTRAI, the Granger causality test is undertaken to determine the direction of causality, i.e whether unidirectional, bidirectional or no causality. The Granger causality test outcomes for LNFDI, LNGDP and LNTRAI (all as endogenous variables) are shown in Table 5-25.

Table 5-25: Granger Causality Test (Endogenous variables: LNFDI, LNGDP, LNTRAI)

Null Hypothesis:	F-Statistic (Prob.)
LNGDP does not Granger Cause LNFDI	0.98265 (0.3267)
LNFDI does not Granger Cause LNGDP	1.89345 (0.1755)
LNTRAI does not Granger Cause LNFDI	1.03767 (0.3137)
LNFDI does not Granger Cause LNTRAI**	4.54792 (0.0383)
LNTRAI does not Granger Cause LNGDP	0.67823 (0.4144)
LNGDP does not Granger Cause LNTRAI*	3.07278 (0.0863)

*Parenthesis () contains the probability values of the F-statistic. Emphasis is placed on *** p<0.01 (Significant at 1 percent level), ** p<0.05 (Significant at 5 percent level) and * p<0.10 (Significant at 10 percent level).*

The outcomes lead to the rejection of the null hypotheses that indicates that LNFDI does not Granger cause LNTRAI and LNGDP does not Granger cause LNTRAI at the 5 per cent and 10 per cent significance levels, respectively. Therefore, it could be concluded that:

- FDI Granger causes transport infrastructure development.
- Economic growth Granger causes transport infrastructure development.

The above Granger causality conclusions imply that there is one-way causality from FDI to transport infrastructure development, and from economic growth to transport infrastructure development.

5.3.2.4 Relationship between LNFDI, LNGDP and LNWATI

Table 5-26: ARDL Models Regression (LNFDI, LNGDP and LNWATI)

	Equation 10	Equation 11	Equation 12
Output Variable	LNFDI	LNGDP	LNWATI
Selected Model	(2,0,3)	(4,0,0)	(1,2,2)
Regressors			
LNFDI	-	-0.003055 (0.9097)	0.012680 (0.8329)
LNFDI(-1)	-0.385436** (0.0208)	-	0.080325 (0.1802)
LNFDI(-2)	-0.523128** (0.0119)	-	-0.169126** (0.0189)
LNGDP	-0.695739 (0.3941)	-	-0.446372 (0.1430)
LNGDP(-1)	-	0.091578 (0.5518)	-0.335276 (0.1495)
LNGDP(-2)	-	-0.284945	-0.272500

		(0.0718)	(0.0521)
LNGDP(-3)	-	-0.235349 (0.0531)	-
LNGDP(-4)	-	-0.196240*** (0.0099)	-
LNWATI	0.067238 (0.8786)	-0.105442 (0.1859)	-
LNWATI(-1)	0.937128 (0.0573)	-	0.473225*** (0.0030)
LNWATI(-2)	-0.073521 (0.8592)	-	-
LNWATI(-3)	0.658207 (0.1009)	-	-
LNOPN	3.455305** (0.0112)	0.613778** (0.0350)	1.273078** (0.0147)
LNINFL	-0.221756 (0.4878)	-0.108617** (0.0346)	-0.175059 (0.1209)
LNEXC	-0.630842 (0.2547)	-0.381490*** (0.0028)	-0.664654*** (0.0015)
LNCRD	0.573607 (0.7496)	-0.434602 (0.1658)	-0.066681 (0.9191)
LNLAB	0.858500 (0.3814)	0.500463** (0.0126)	0.597459 (0.0689)
DUM	-0.792393 (0.3636)	0.207331 (0.1685)	0.252213 (0.4076)
Constant	-36.77434 (0.0008)	2.318202 (0.1956)	8.115750 (0.0467)
Adjusted R^2	0.354543	0.556457	0.682380
DW statistic	2.227828	2.219191	2.221671
F-statistic	2.943645*** (0.0061)	5.704643*** (0.0000)	8.767368*** (0.0000)

*The First line contains estimated coefficients, in parenthesis () are the probability values (p-values). Emphasis is placed on *** p<0.01 (Significant at 1 per cent level) and ** p<0.05 (Significant at 5 per cent level). Each term's p-value tests the null hypothesis of no effect from the respective independent variable on the regressand (that coefficient is equal to zero). Therefore, the null hypothesis can be rejected when the p-value is low (< 0.05). DW is the Durbin-Watson statistic.*

The regression analysis results in Table 5-26 show that the optimal lag lengths are (2, 0, 3), (4, 0, 0) and (1, 2, 2) for the equations with LNFDI, LNGDP and LNWATI as dependent variables respectively. The deterministic trend is statistically insignificant in all the three equations at the 5 per cent significance level, hence excluded in the two equations.

The findings further reveal that the adjusted R-squared values are 35.5 per cent, 55.6 per cent and 68.2 per cent for the equations where LNFDI, LNGDP and LNWATI are the dependent variables, respectively. The models overall F-statistics indicate that the variations in any of the dependent variables are accounted for by at least one of the explanatory variables (p-values are 0.0061, 0.0000 and 0.0000 for Equation 10, Equation 11 and Equation 12, respectively).

The Durbin-Watson statistics have all values of approximately 2 and are all above the value of 1.98597 (for a sample of 50 observations, with 3 dynamic regressors, and 8 fixed regressors) indicating that there is no autocorrelation in the errors of the regression models. An extreme value of the Durbin-Watson statistic around 1 or 4 would indicate possible autocorrelation in the errors.

From the findings of the analysis, the one-period and two-period lags of FDI have statistically significant effects on current levels of FDI. The market openness (p-value 0.0112, coefficient 3.4553) positively influences FDI. The four-period lag of economic growth (p-value 0.0099, coefficient -0.1962), inflation rate (p-value 0.0346, coefficient -0.1086) and exchange rate (p-value 0.0028, coefficient -0.3815) have negative effect on economic growth. The market openness (p-value 0.0350, coefficient 0.6138) and labour resources (p-value 0.0126, coefficient 0.5005) positively impact economic growth. The two-period lag of FDI (p-value 0.0189, coefficient -0.1691) and the exchange rate (p-value 0.0015, coefficient -0.6647) have a negative impact on water infrastructure development. The one-period lag of water infrastructure (p-value 0.0030, coefficient 0.4732) and the market openness (p-value 0.0147, coefficient 1.2731) have a positive effect on water infrastructure investments. All the cited p-values are < 0.05, and hence the null hypotheses of no effect on the respective dependent variables are rejected.

Table 5-27: Diagnostic Tests (LNFDI, LNGDP and LNWATI)

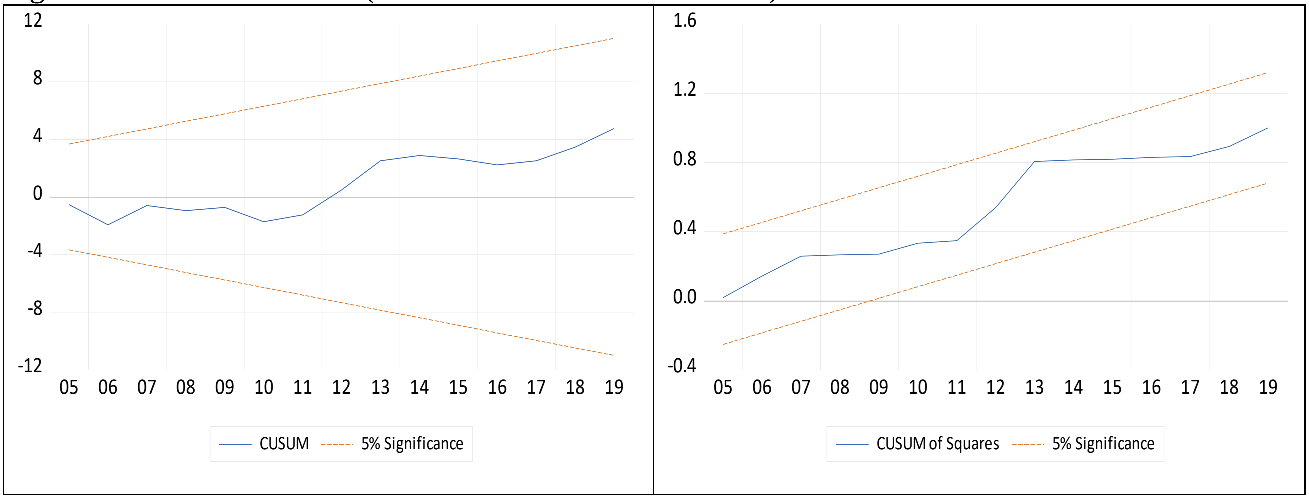
Equation	Dependent Variable	Independent Variables	Ramsey RESET	Jarque-Bera Statistic	Breusch-Godfrey LM	Breusch-Pagan-Godfrey
10.	LNFDI	LNGDP LNWATI LNOPN LNINFL LNEXC LNCRD LNLAB	4.7253** (0.0372)	9.0186** (0.0110)	1.2186 (0.3094)	1.0021 (0.4713)
11.	LNGDP	LNFDI LNWATI LNOPN LNINFL LNEXC LNCRD LNLAB	0.1862 (0.6690)	6.1924** (0.0452)	0.5857 (0.5627)	0.3960 (0.9551)
12.	LNWATI	LNFDI LNGDP LNOPN LNINFL LNEXC LNCRD LNLAB	1.5076 (0.2282)	0.9364 (0.6261)	1.2707 (0.2944)	1.4012 (0.2092)

*The F statistics on the first line, probability values in parenthesis (). (**) Significant at 5 per cent, and (***) Significant at 1 per cent. {Emphasis is placed on *** p<0.01 (1%), ** p<0.05 (5%)}. Low p-values (< 0.05) indicate the existence of diagnostic abnormality, and the null hypothesis cannot be rejected.*

The Jarque-Bera normality test has a failure in the equations where LNFDI and LNGDP are the dependent variables. The Ramsey RESET test fails in the equation where LNFDI is the dependent variable (equation 10). However, a failure in the normality test does not lend the obtained estimates inconsistent, and inference can be made if other diagnostics are satisfactory. The serial correlation and homoskedasticity (constant variance) tests are all satisfactory. Despite the failure in the Ramsey RESET test, there is parameter stability in the LNFDI dependent variable model as shown by the CUSUM plots in Figure 5-14.

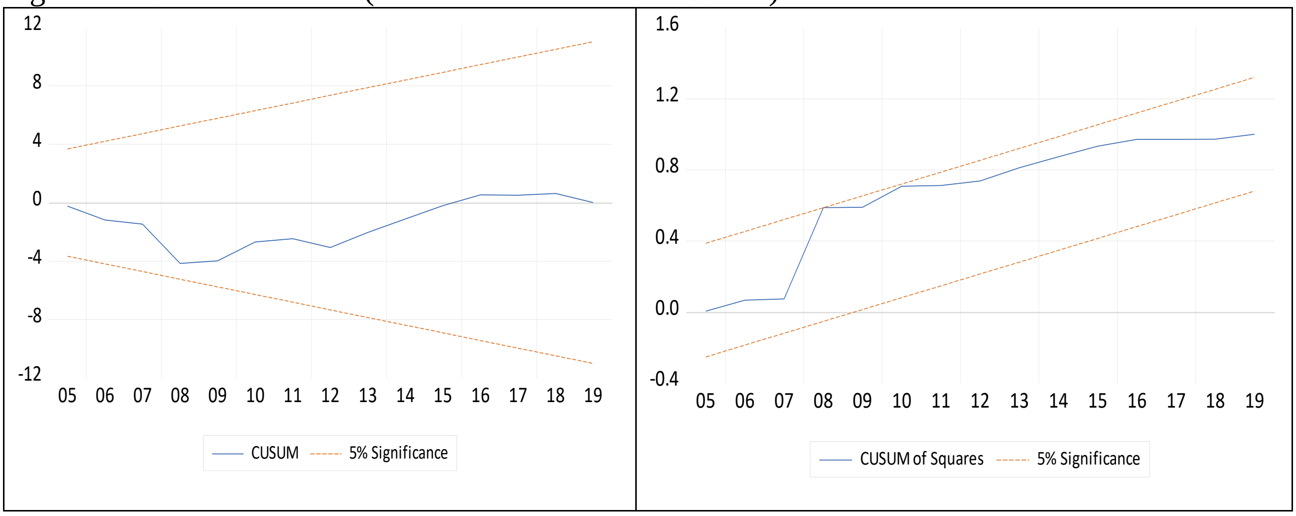
The CUSUM plots lie largely within the 5 per cent significance level boundary, as shown in figures 5-14 to 5-16. Therefore, there is significant parameter constancy and no detected systematic alteration in the coefficients (model stability) in all the regression analyses (equations 10, 11 and 12).

Figure 5-14: CUSUM Plots (LNFDI = LNGDP + LNWATI)



In the equation where FDI is the regressand, and economic growth, water infrastructure and control variables are the exogenous variables, the CUSUM and CUSUM of Squares plots lie within the 5 per cent significance level boundaries. The implication is that there is parameter constancy in the regression model.

Figure 5-15: CUSUM Plots (LNGDP = LNFDI + LNWATI)



There is parameter constancy in the regression model where economic growth is the dependent variable, and FDI, water infrastructure and control variables are the independent variables. This is shown by the above CUSUM and CUSUM of Squares plots that lie within the 5 per cent significance level boundaries.

Figure 5-16: CUSUM Plots (LNWATI = LNFDI + LNGDP)

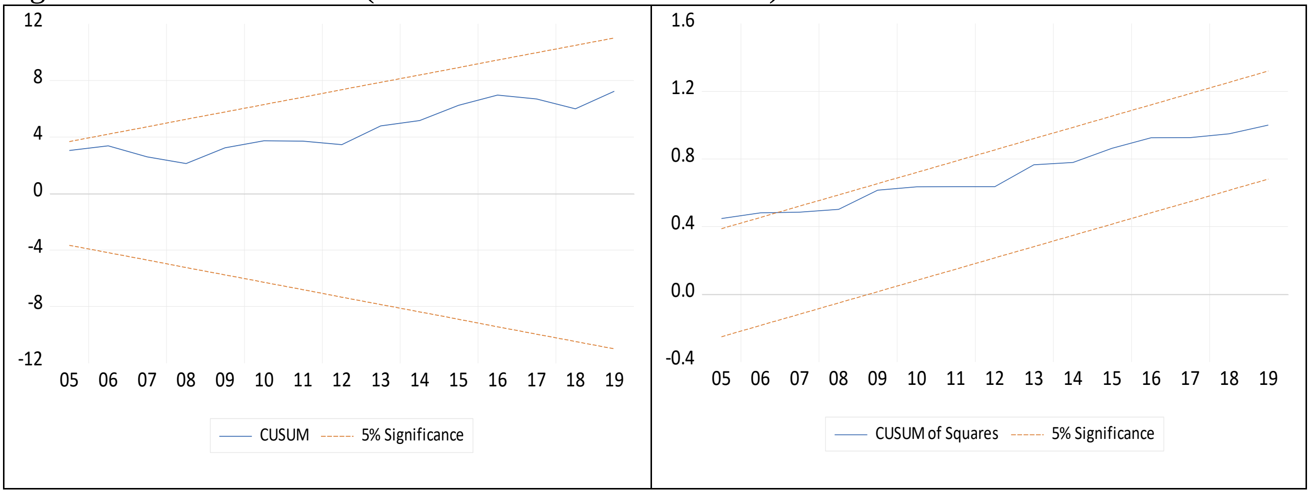


Figure 5-16 above shows that the CUSUM plots mostly lie within the 5 per cent significance level boundary, implying that there is parameter stability in the equation.

The cointegration test results for the relationship between LNFDI, LNGDP and water infrastructure are displayed in Table 5-28.

Table 5-28: ARDL Bounds Cointegration Tests (LNFDI, LNGDP and LNWATI)

Equation	Dependent Variable	Independent Variables	Long-Run Relationship		F-statistic	t-statistic
			Coefficients	Probability		
10.	LNFDI	LNWATI	0.832591***	0.0020	17.28363***	-7.109321***
		LNGDP	-0.364535	0.3823		
11.	LNGDP	LNWATI	-0.064889	0.1532	14.67519***	-6.406317***
		LNFDI	-0.001880	0.9098		
12.	LNWATI	LNFDI	-0.144504	0.6272	9.018606***	-3.553950**
		LNGDP	-2.001136**	0.0291		

*The F statistics on the first line, probability values in parenthesis (). (**) Significant at 5 per cent, and (***) Significant at 1 per cent. {Emphasis is placed on *** p<0.01 (1%), ** p<0.05 (5%)}. Low p-values (< 0.05) indicate the existence of diagnostic abnormality, and the null hypothesis cannot be rejected.*

The ARDL cointegration test results show that when LNFDI is the dependent variable, both the overall F-statistic (17.28) and the t-statistic (-7.11) are larger than the respective upper bounds critical values (6.36 and -4.1, respectively) at the 1 per cent significance level (see Appendix 2(jj)). Therefore, there is the rejection of the null hypothesis of no cointegration of the variables. The cointegration test outcomes further reveal that water infrastructure (LNWATI) has a positive causal effect in the long-run on foreign direct investment (LNFDI). At the 1 percent significance level infrastructure development (water) is statistically significant (p-value 0.0020 < 0.01, coefficient 0.8326). The result may be interpreted to mean that a 1 per cent change in water infrastructure development may result in a 0.83 per cent change in the attractiveness of Kenya to the inflow of FDI.

The no cointegration null hypothesis is also rejected in the equation where LNGDP is the dependent variable. The bounds test indicate that the overall F-statistic (14.68) exceeds the upper bound critical value (6.36) at 1 per cent significance level, and in absolute terms the t-statistic (-6.41) exceeds the respective upper bound critical value (-4.1) at 1 per cent significance level (see Appendix 2(mm)). Therefore, the null hypothesis of no cointegration of the variables of study in this equation is rejected. In the long-run, both FDI and water infrastructure do not have a statistically significant effect on economic growth.

In the equation where LNWATI is the regressand, the overall F-statistic is larger than the upper bound critical value (9.02 compared to 6.36) at the 1 per cent significance level, and the absolute t-statistic exceeds the upper bound critical value (-3.55 compared to -3.53) at the 5 per cent significance level (see Appendix 2(pp)). Therefore, the null hypothesis of no levels relationship is rejected in favour of the existence of cointegration. In the long-run, economic growth has a statistically significant negative effect on water infrastructure (p-value 0.0291, coefficient -2.001). This finding suggests that a 1 per cent rise in economic growth leads to a reduction in the provision of water services by 2.0 per cent. The possible explanation is that other areas of infrastructure would possibly receive priority over water supply when the economy grows.

The long-run models are presented next:

$$LNFDI_t = -0.3645^{*}LNGDP_t + 0.8326^{*}LNWATI_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (44)$$

$$LNGDP_t = -0.0019^{*}LNFDI_t - 0.0649^{*}LNWATI_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (45)$$

$$LNWATI_t = -0.1445^{*}LNFDI_t - 2.0011^{*}LNGDP_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (46)$$

Table 5-29: ARDL Error Correction Model Regression (D(LNFDI), D(LNGDP) and D(LNWATI))

	Equation 10	Equation 11	Equation 12
Output Variable	D(LNFDI)	D(LNGDP)	D(LNWATI)
Regressors			
D(LNFDI)	-	-	0.012680 (0.7371)
D(LNFDI(-1))	0.523128*** (0.0070)	-	0.169126*** (0.0002)
D(LNGDP)	-	-	-0.446372 (0.3870)
D(LNGDP(-1))	-	0.716535*** (0.0002)	0.272500** (0.0190)
D(LNGDP(-2))	-	0.431590*** (0.0016)	-
D(LNGDP(-3))	-	0.196240*** (0.0076)	-
D(LNWATI)	0.067238 (0.8549)	-	-
D(LNWATI(-1))	-0.584686 (0.1164)	-	-
D(LNWATI(-2))	-0.658207 (0.0659)	-	-
LNOPN	3.455305*** (0.0038)	0.613778*** (0.0062)	1.273078*** (0.0056)
LNINFL	-0.221756 (0.3936)	-0.108617** (0.0297)	-0.175059 (0.0817)
LNEXC	-0.630842 (0.0660)	-0.381490*** (0.0001)	-0.664654*** (0.0005)
LNCRD	0.573607 (0.7413)	-0.434602 (0.1502)	-0.066681 (0.9149)
LNLAB	0.858500 (0.2803)	0.500463*** (0.0040)	0.597459 (0.0521)
DUM	-0.792393 (0.3235)	0.207331 (0.1475)	0.252213 (0.3617)
Constant	-36.77434 (0.0003)	2.318202 (0.0968)	8.115750 (0.0042)

ECT (-1)	-1.908564*** (0.0000)	-1.624957*** (0.0000)	-0.526775*** (0.0000)
Diagnostics			
Breusch-Godfrey LM	1.218609 (0.3094)	0.585738 (0.5627)	1.270749 (0.2944)
Breusch-Pagan-Godfrey	1.002130 (0.4713)	0.395967 (0.9551)	1.401192 (0.2092)
Ramsey RESET	4.725309** (0.0372)	0.186159 (0.6690)	1.507640 (0.2282)

*The First line contains estimated coefficients, in parenthesis () are the probability values. Emphasis is placed on *** p<0.01 (Significant at 1 per cent level) and ** p<0.05 (Significant at 5 per cent level).*

The ARDL short-run regression results shown in Table 5-29 reveal that the error correction term is negative (-1.91) in equation 10 when D(LNFDI) is the regressand. The error term is rightly negative and statistically significant at the 1 per cent significance level, as indicated by the probability value of 0.0000. The negative sign of the ECT indicates that the system tends to revert to the point of equilibrium even when the cointegrating relationship experiences the short-run deviation. The findings indicate that the long-run speed of adjustment to the equilibrium is 191 per cent, hence rapid. The one-period lag of FDI and market openness have a statistically significant (at 1 per cent significance level) positive short-run causal effect on FDI. This implies that a 1 per cent change in the one-period lag of FDI causes a 0.52 per cent change in the same direction in FDI. Similarly, a 1 per cent change in market openness causes a 3.46 per cent change in the same direction in FDI.

In the equation where economic growth (D(LNGDP)) is the regressand (equation 11), the error correction term is rightly negative (-1.62) and statistically significant at the 1 per cent level (p-value 0.0001 < 0.01). The adjustment speed to the long-run equilibrium is 162.5 per cent. The findings reveal that the one-period, two-period and three-period lags of the regressand (D(LNGDP(-1), D(LNGDP(-2) and D(LNGDP(-3)) have a statistically significant and positive causal impact on the economic growth. This means that past values of economic growth may determine future economic performance. The three outcomes are valid at the 1 per cent significance level. The market openness (p-value 0.0062, coefficient 0.6138) and labour resources (p-value 0.0040, coefficient 0.5005) also positively influence the rate of economic growth. Furthermore, the rate of inflation (p-value 0.0297, coefficient -0.1086) and the exchange rate (p-value 0.0001, coefficient -0.3815) have a statistically significant negative impact on the rate of economic growth.

The error correction regression outcomes of the equation where (D(LNWATI)) is the dependent variable show an ECT (-0.527) that is negative and statistically significant at the 1 per cent significance level (p-value of 0.0000). This result suggests that the reversion to the equilibrium after a short-run shock is at a speed of 52.7 per cent. The ARDL short-run regression results further show that the one-period lag of FDI has a positive and statistically significant (at 1 per cent significance level since p-value 0.0002 < 0.01) short-run causal effect on water infrastructure development. By implication, a 1 per cent expansion in FDI in the past year may lead to a 0.17 per cent rise in investments in water infrastructure in the current year. The one-period lag of economic growth variable and market openness influence water infrastructure investments positively. A 1 per cent increase in the one-period lag of economic growth and a 1 per cent increase in market openness lead to an increase of 0.27 per cent and 1.27 per cent in water infrastructure development, respectively. The exchange rate has a statistically significant negative short-run causal impact on water infrastructure development. A 1 per cent change in the exchange rate causes investment in water infrastructure to change in the opposite direction by 0.66 per cent. Water infrastructure development is tamed by unfavourable exchange rates.

Most of the important diagnostics for the three equations are satisfactory (all p-values < 0.05). This done, we now proceed to establish possible causality in the series. The Granger causality test is undertaken to determine the direction of causality, i.e., whether the causality is unidirectional, bidirectional or no causality between the three variables of analysis. The result of the causality test is presented in Table 5-30.

Table 5-30: Granger Causality Test (Endogenous variables: LNFDI, LNGDP, LNWATI)

Null Hypothesis:	F-Statistic (Prob.)
LNGDP does not Granger Cause LNFDI	1.19887 (0.3114)
LNFDI does not Granger Cause LNGDP	0.64063 (0.5319)
LNWATI does not Granger Cause LNFDI***	7.70273 (0.0014)
LNFDI does not Granger Cause LNWATI***	5.13990 (0.0100)
LNWATI does not Granger Cause LNGDP	2.09725 (0.1352)
LNGDP does not Granger Cause LNWATI	0.17059 (0.8437)

*Parenthesis () contains the probability values of the F-statistic. Emphasis is placed on *** p<0.01 (Significant at 1 percent level), ** p<0.05 (Significant at 5 percent level) and * p<0.10 (Significant at 10 percent level).*

At the 1 per cent significance level, the Granger causality results indicate that the null hypotheses implying that LNWATI does not Granger cause LNFDI, and LNFDI does not Granger cause LNWATI are rejected (p-values are < 0.01). This indicates that there is bi-directional causality between FDI and water infrastructure development. Therefore:

- Water infrastructure development Granger causes FDI.
- FDI Granger causes water infrastructure development.

5.3.2.5 Relationship between LNFDI, LNGDP and LNICTI

Table 5-31: ARDL Models Regression (LNFDI, LNGDP and LNICTI)

	Equation 13	Equation 14	Equation 15
Output Variable	LNFDI	LNGDP	LNICTI
Selected Model	(2,0,1)	(3,2,3)	(2,1,0)
Regressors			
LNFDI	-	-0.040636 (0.2225)	-0.028817 (0.0507)
LNFDI(-1)	-0.298572** (0.0469)	-0.064783 (0.0802)	-
LNFDI(-2)	-0.324430** (0.0427)	-0.046295 (0.1962)	-
LNGDP	-0.677730 (0.3283)	-	0.035258 (0.6315)
LNGDP(-1)	-	0.087710 (0.6487)	-0.136549** (0.0402)
LNGDP(-2)	-	-0.346614** (0.0247)	-
LNGDP(-3)	-	-0.188696** (0.0322)	-
LNICTI	-3.813055*** (0.0014)	0. 029064 (0.9334)	-

LNICTI(-1)	3.416614 (0.4700)	-1.214965 (0.0514)	1.388703*** (0.0000)
LNICTI(-2)	-	1.382684** (0.0310)	-0.580529*** (0.0000)
LNICTI(-3)	-	-0.430076 (0.1820)	-
LNOPN	4.941075*** (0.0021)	1.043324*** (0.0066)	0.274521 (0.0648)
LNINFL	-0.425527 (0.1899)	-0.133043** (0.0431)	-0.022442 (0.4586)
LNEXC	-1.041898** (0.0198)	-1.132809** (0.0247)	-0.294001 (0.0532)
LNCRD	-0.421304 (0.8082)	-0.422953 (0.2320)	-0.001873 (0.9913)
LNLAB	2.395686 (0.0895)	-0.149900 (0.7802)	-0.181415 (0.4022)
DUM	0.249088 (0.8313)	0.111650 (0.6714)	0.244639 (0.0331)
Constant	-15.83321 (0.1311)	11.72535 (0.1264)	5.188059 (0.0614)
Deterministic Trend	-	0.125353 (0.0766)	0.053791 (0.0252)
Adjusted R^2	0.387090	0.543652	0.998644
DW statistic	2.385689	2.355920	1.847196
F-statistic	3.698489*** (0.0014)	4.223540*** (0.0003)	2886.320*** (0.0000)

*The first line contains estimated coefficients, in parenthesis () are the probability values (p-values). Emphasis is placed on *** p<0.01 (Significant at 1 per cent level) and ** p<0.05 (Significant at 5 per cent level). Each term's p-value tests the null hypothesis of no effect from the respective independent variable on the regressand (that coefficient is equal to zero). Therefore, the null hypothesis can be rejected when the p-value is low (< 0.05). DW is the Durbin-Watson statistic.*

The selected optimal lag length when LNFDI is the dependent variable is (2,0,1), implying two lags for the regressand (LNFDI), no lags for the first dynamic regressor (LNGDP) and one lag for the second dynamic regressor in the equation (LNICTI). The regressors (including the control variables) in this equation explain 38.7 per cent of the variations in the regressand. The F-statistic is statistically significant at the 1 per cent level (p-value 0.0014) hence at least one of the regressors affects the dependent variable. At the 5 per cent significance level, the deterministic trend is statistically insignificant, hence excluded from the analysis. The null hypothesis of no effect of the regressor on the dependent variable can be rejected when the p-value is low (< 0.05). The p-values from this regression indicate that the one-period lag of FDI (p-value 0.0469, coefficient -0.2986), two-period lag of FDI (p-value 0.0427, coefficient -0.3244), current period ICT infrastructure (p-value 0.0014, coefficient -3.8131), and the exchange rate (p-value 0.0198, coefficient -1.0419) have all statistically significant negative effect on FDI. The market openness (p-value 0.0021, coefficient 4.9411) has a positive effect on FDI.

In the equation where LNGDP is the regressand, the optimal lag length chosen is (3, 2, 3). The deterministic trend is statistically insignificant at the 5 per cent level of significance and therefore not included in the regression. The regressors account for 54.4 per cent of the variations in the regressand. The overall F-statistic is also at the 1 per cent significance level, which indicates a statistically significant result (p-value 0.0003). The two-period lag of economic growth (p-value 0.0247, coefficient -0.3466), three-period lag of economic growth (p-value 0.0322, coefficient -0.1887), inflation rate (p-value 0.0431, coefficient -1.3330), and exchange rate (p-value 0.0247, coefficient -1.1328) have statistically significant negative effects on economic growth. The two-period lag of ICT infrastructure (p-value 0.0310, coefficient 1.3827) and market openness (p-value 0.0066, coefficient 1.0433) have statistically significant positive effects on economic growth.

When LNICTI is the dependent variable, the optimal lag length is (2, 1, 0). The deterministic trend in this equation is statistically significant at the 5 per cent significance level, hence included in the model. The goodness of fit (adjusted R^2) of 0.998 means that the regressors explain 99.8 per cent of the variations in the regressand. The F-statistic is statistically significant at the 1 per cent significance level (p-value 0.0000), indicating that no less than one of the explanatory variables is responsible for variations in the dependent variable. The one-period lag of GDP (p-value 0.0402, coefficient -0.1365) and two-period lag of ICT infrastructure (p-value 0.0000, coefficient -0.5805) have negative effects on ICT infrastructure development. The one period lag of ICT infrastructure (p-value 0.0000, coefficient 1.3887) has a positive effect on ICT infrastructure development.

The Durbin-Watson statistics are satisfactory for the equations where LNFDI and LNGDP are the regressands (2.385689, and 2.355920, respectively). The two DW statistics are exceeding the upper bound (D_U) statistic (1.98597) for a sample of 50 observations with 10 regressors - 3 dynamic regressors, and 8 fixed regressors including the control variables, the dummy variable, and the constant. For Equation 15 where LNICTI is the regressand and the number of regressors are 11 including the deterministic trend, the DW statistic (1.847196) falls between the upper bound (2.04368) and the lower bound D_L (1.11021) statistics. Savin and White (1977) also specify that If $(4 - DW) > D_U$, no correlation exists. For our case, $4 - 1.847196 = 2.152804$ which is greater than 2.04368, implying that no correlation exists. Therefore, in the three models, there is no autocorrelation in the errors of the regression.

Table 5-32: Diagnostic Tests (LNFDI, LNGDP and LNICTI)

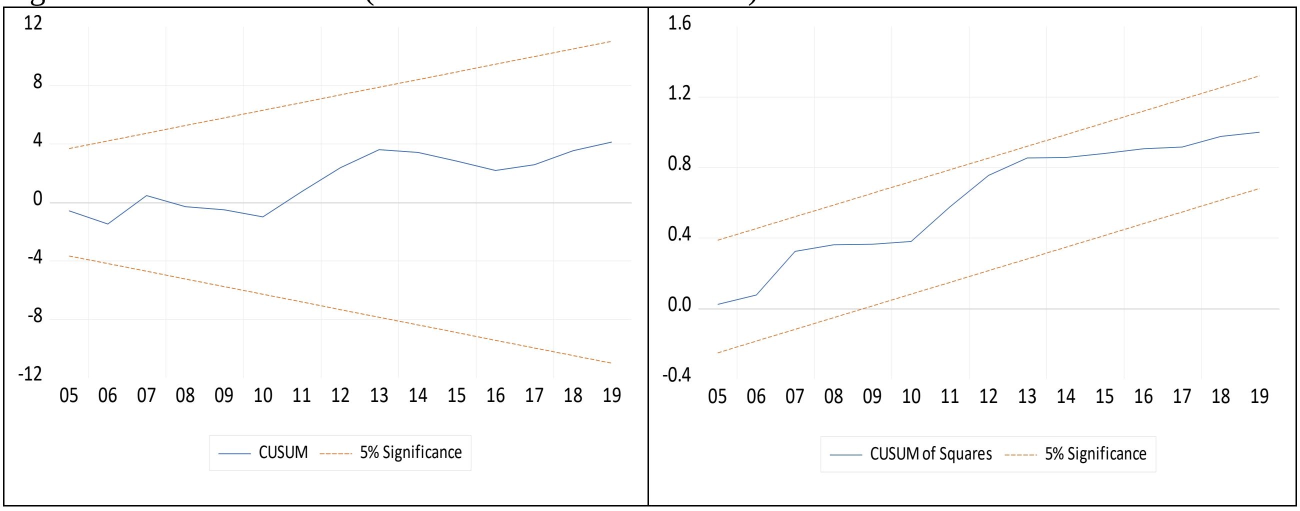
Equation	Dependent Variable	Independent Variables	Ramsey RESET	Jarque-Bera Statistic	Breusch-Godfrey LM	Breusch-Pagan-Godfrey
13.	LNFDI	LNGDP LNICTI LNOPN LNINFL LNEXC LNCRD LNLAB	0.0201 (0.8882)	36.4189*** (0.0000)	2.8811 (0.0698)	1.0586 (0.4195)
14.	LNGDP	LNFDI LNICTI LNOPN LNINFL LNEXC LNCRD LNLAB	3.0361 (0.0924)	1.5072 (0.4707)	1.7633 (0.1907)	0.4174 (0.9689)
15.	LNICTI	LNFDI LNGDP LNOPN LNINFL LNEXC LNCRD	0.1972 (0.6598)	85.9866*** (0.0000)	0.5230 (0.5976)	1.8112 (0.0849)

		LNLAB				

*The F statistics on the first line, probability values in parenthesis (). (**) Significant at 5 per cent, and (***) Significant at 1 per cent. {Emphasis is placed on *** p<0.01 (1%), ** p<0.05 (5%)}. Low p-values (< 0.05) indicate the existence of diagnostic abnormality, and the null hypothesis cannot be rejected.*

The diagnostics test results shown in Table 5-32 are largely satisfactory. The residual normality test (Jarque-Bera) fails in the equations where LNFDI and LNICTI are the dependent variables (both p-values are 0.0000 < 0.01). However, when data are non-normally distributed but other model diagnostics are satisfactory, estimates obtained from the analysis are still consistent and inferences can be made from them. Therefore, the three ARDL model regressions are well specified (Ramsey RESET functional form test), no serial correlation (Breusch-Godfrey LM test) and homoscedastic (Breusch-Pagan-Godfrey heteroskedasticity test), and hence inferences can be made from the findings of the analyses.

Figure 5-17: CUSUM Plots (LNFDI = LNGDP + LNICTI)



In the CUSUM tests above where LNFDI is the dependent variable, there is significant parameter constancy and no detected systematic alteration in the coefficients (model stability).

Figure 5-18: CUSUM Plots (LNGDP = LNFDI + LNICTI)

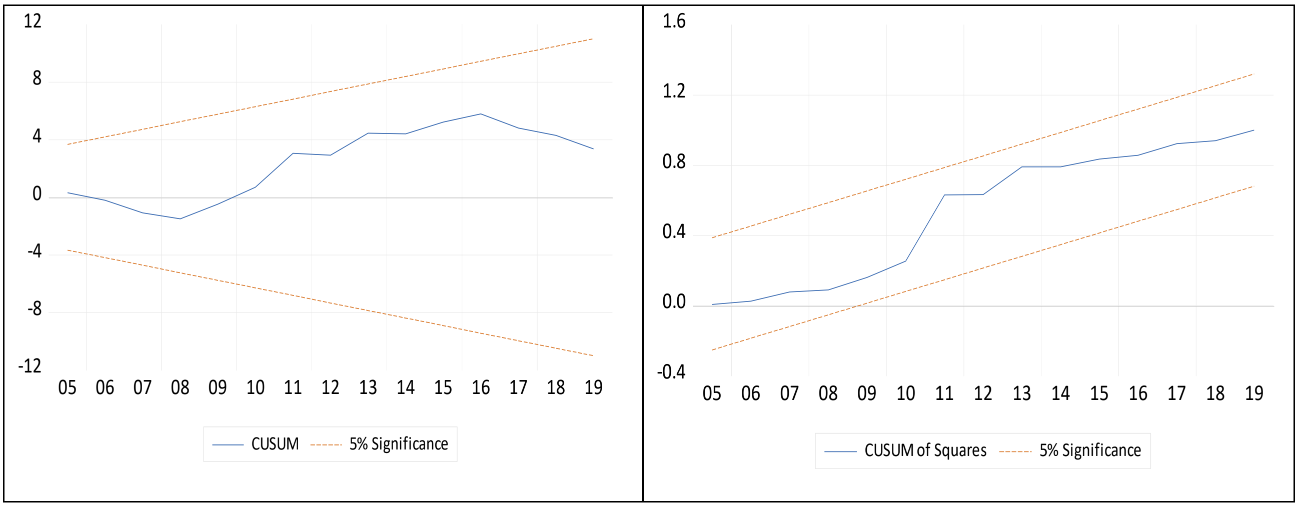
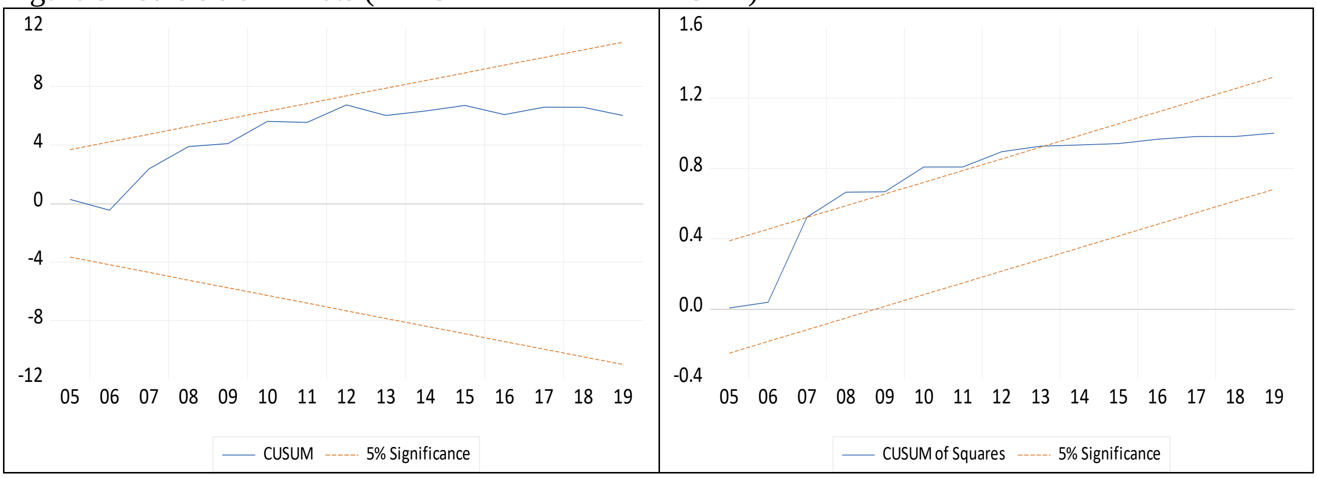


Figure 5-18 indicate significant parameter constancy when LNGDP is the dependent variable while LNFDI, LNICTI and the control variables are the explanatory variables. The CUSUM and CUSUM of Squares plots lie within the 5 per cent significant boundary.

Figure 5-19: CUSUM Plots (LNICTI = LNFDI + LNGDP)



In the equation where LNICTI is the dependent variable, and LNFDI and LNGDP as independent variables, Figure 5-18 indicate significant parameter constancy when LNGDP is the dependent variable while LNFDI, LNICTI and the control variables are the explanatory variables. The CUSUM and CUSUM of Squares plots lie within the 5 per cent significant boundary.

Figure 5-19 shows that the parameters are constant, and the model is stable as shown in the plot of the CUSUM test. The plot of the CUSUM of squares indicates possible model parameter instability.

The outcomes of the ARDL bounds cointegration tests between LNFDI, LNGDP and LNICTI are presented in Table 5-33.

Table 5-33: ARDL Bounds Cointegration Tests (LNFDI, LNGDP and LNICTI)

Equation	Dependent Variable	Independent Variables	Long-Run Relationship		F-statistic	t-statistic
			Coefficients	P-Value		
13.	LNFDI	LNICTI	-0.244264	0.4330	17.00669***	-7.100889***
		LNGDP	-0.417578	0.3224		
14.	LNGDP	LNICTI	-0.161159	0.1150	9.307375***	-5.257620***
		LNFDI	-0.104804	0.1400		
15.	LNICTI	LNFDI	-0.150227	0.1188	6.457054**	-4.525272**
		LNGDP	-0.528037	0.2093		

(***) Significant at 1 per cent, (**) Significant at 5 per cent, and (***) Significant at 1 per cent. P-values are in parentheses (). Low p-values (< 0.10) indicate the significance of the effect of the independent variable on the regressand in the long-run. The significance of the F-statistic and t-statistic is based on upper and lower bounds critical values given by Pesaran et al. 2001 (see Table 5-9).

In the cointegration test results contained in Table 5-33, when LNFDI is the regressand the overall F-statistic (17.00) is larger at the 1 per cent significance level than the respective upper bound critical value (6.36) – see Appendix 2 (uu). The t-statistic (-7.10) is also above the upper bound critical value (-4.1) at the 1 per cent significance level. Consequently, the no cointegration null hypothesis is rejected. The FDI, economic growth and infrastructure development (ICT) are in the long-run cointegrated.

In the equation where LNGDP is the regressand, the overall F-statistic of 9.31 is greater than the upper bound critical value of 7.52 at the 1 per cent significance level (see Appendix 2 (xx)). The absolute t-statistic value of –5.26 is also at the 1 per cent significance level above the respective upper bound critical value of –4.53. The findings of the overall F-statistic and t-statistic imply that the no cointegration null hypothesis in this equation is rejected.

Finally, when LNICTI is the regressand in the cointegration test equation, the overall F-statistic (6.46) is larger than the upper bound critical value (5.85) at the 5 per cent significance level. The absolute t-statistic (-4.53) is above the upper bound critical value (-3.95) at the 5 per cent significance level – see Appendix 2 (aaa). Consequently, the no cointegration null hypothesis is rejected. The long-run results show no statistically significant effect on ICT infrastructure emanating from FDI and economic growth.

$$LNFDI_t = -0.4176^{*}LNGDP_t - 0.2443^{*}LNICTI_t \ldots \quad (47)$$

$$LNGDP_t = -0.1048^{*}LNFDI_t - 0.1612^{*}LNICTI_t \ldots \quad (48)$$

$$LNICTI_t = -0.1502^{*}LNFDI_t - 0.5280^{*}LNGDP_t \ldots \quad (49)$$

Table 5-34: ARDL Error Correction/Short-run Model Regression (D(LNFDI), D(LNGDP) and D(LNICTI))

	Equation 13	Equation 14	Equation 15
Dependent Variable	D(LNFDI)	D(LNGDP)	D(LNICTI)
Regressors			
D(LNFDI)	-	-0.040636 (0.0765)	-
D(LNFDI(-1))	0.324430** (0.0359)	0.046295 (0.0769)	-
D(LNGDP)	-	-	0.035258 (0.5468)
D(LNGDP(-1))	-	0.535310*** (0.0032)	-
D(LNGDP(-2))	-	0.188696** (0.0255)	-
D(LNICTI)	-3.813055*** (0.0009)	0.029064 (0.9218)	-
D(LNICTI (-1))	-	-0.952607*** (0.0097)	0.580529*** (0.0000)
D(LNICTI (-2))	-	0.430076 (0.1654)	-
LNOPN	4.941075*** (0.0001)	1.043324*** (0.0003)	0.274521 (0.0574)
LNINFL	-0.425527 (0.0909)	-0.133043** (0.0338)	-0.022442 (0.4198)
LNEXC	-1.041898** (0.0154)	-1.132809** (0.0154)	-0.294001** (0.0330)

LNCRD	-0.421304 (0.7969)	-0.422953 (0.2093)	-0.001873 (0.9910)
LNLAB	2.395686*** (0.0048)	-0.149900 (0.7658)	-0.181415 (0.3640)
DUM	0.249088 (0.7432)	0.111650 (0.5760)	0.244639 (0.0203)
Constant	-15.83321 (0.0436)	11.72535 (0.1124)	5.188059 (0.0349)
Deterministic Trend	-	0.125353 (0.0543)	0.053791 (0.0125)
ECT (-1)	-1.623002*** (0.0000)	-1.447600*** (0.0000)	-0.191826*** (0.0001)
Diagnostics			
Breusch-Godfrey LM	2.881136 (0.0698)	1.763325 (0.1907)	0.522978 (0.5976)
Breusch-Pagan-Godfrey	1.058648 (0.4195)	0.417438 (0.9689)	1.811188 (0.0849)
Ramsey RESET	0.020063 (0.8882)	3.036085 (0.0924)	0.197238 (0.6598)

*The First line contains estimated coefficients, in parenthesis () are the probability values. Emphasis is placed on * p<0.01 (Significant at 1 per cent level) and ** p<0.05 (Significant at 5 per cent level).*

According to Table 5-34, the coefficient of the ECT in equation 13 where D(LNFDI) is the regressand has the correct negative sign (-1.623), which is statistically significant at 1 per cent level (p-value = 0.0000). The speed of convergence of the system to equilibrium is 162.3 per cent. This confirms cointegration and the stability of the system. The one-period lag of FDI, market openness and labour resources have a statistically significant positive impact on FDI in the short-run. A 1 per cent rise in the one-period lag of FDI, market openness and labour resources may cause 0.32, 4.94 and 2.40 percentages rise in FDI, respectively. The ICT infrastructure negatively influences FDI in the short-run. This result is statistically significant at the 1 per cent level. The finding suggests that a 1 per cent increase in ICT infrastructure may cause FDI to decrease by 3.82 per cent. The exchange rate also has a negative effect on FDI in the short-run. A 1 per cent increase in the exchange rate may cause the FDI to decrease by 1.04 per cent.

In equation 14 where LNGDP is the regressand, the ECT (-1.45) is statistically significant and negative. The rate of adjustment towards long-run equilibrium is 145 per cent. The findings further reveal that one-period and two-period lags in GDP, and market openness have a statistically significant positive impact on economic growth in the short-run. A one per cent rise in one-period lag in GDP, two-period lag in GDP and market openness may cause economic growth in the short-run to rise by 0.54 per cent, 0.19 per cent and 1.04 per cent, respectively. The one-period lag of ICT infrastructure (p-value 0.0097, coefficient -0.9526), at the 1 per cent significance level, has a negative and significant short-run causal impact on economic growth. A 1 per cent increase in the one-period lag of ICT infrastructure causes economic growth to decrease by 0.95 per cent. This implies that past investments in ICT infrastructure may have an adverse impact on economic growth. The rate of inflation (p-value 0.0338, coefficient -0.1330) and exchange rate (p-value 0.0154, coefficient -1.1328) have a negative impact on economic growth, both at the 5 per cent significance level.

Finally, in the equation where LNICTI is the regressand, the coefficient of the ECT has the correct negative sign (-0.192), which has statistical significance at the 1 per cent level (p-value 0.0001). The speed of convergence of the system to equilibrium is 19.2 per cent. The empirical analysis outcome shows that the ICT infrastructure's past values (one-period lag of ICT infrastructure with a p-value of $0.0000 < 0.01$) at the 1 per cent significance level has a significant and positive causal impact on ICT infrastructure. By implication, a 1 per cent rise in ICT infrastructure investment this year may lead to a 0.58 per cent growth in ICT infrastructure in the following year. The exchange rate has a negative impact on ICT infrastructure growth in the short-run. A 1 per cent rise in the exchange rate may lead to a 0.29 per cent decrease in ICT infrastructure development. This is possible because quite a substantial part of the equipment for IT infrastructure has been imported into the country.

All the important diagnostics for the three equations are satisfactory (all p-values < 0.05). Residual serial correlation is determined to be absent in the models, there is a constant variance of the residuals (homoscedasticity), and the models are well specified as shown by the Ramsey RESET tests.

Following the confirmation of the existence of cointegration between LNFDI, LNGDP and LNICTI, the Granger causality test was undertaken to determine the direction of causality.

Table 5-35: Granger Causality Test (Endogenous variables: LNFDI, LNGDP, LNICTI)

Null Hypothesis:	F-Statistic (Prob.)
LNGDP does not Granger Cause LNFDI	0.65189 (0.5864)
LNFDI does not Granger Cause LNGDP	1.34987 (0.2719)
LNICTI does not Granger Cause LNFDI*	2.65491 (0.0615)
LNFDI does not Granger Cause LNICTI	1.47187 (0.2367)
LNICTI does not Granger Cause LNGDP**	3.24822 (0.0317)
LNGDP does not Granger Cause LNICTI	1.01754 (0.3950)

*Parenthesis () contains the probability values of the F-statistic. Emphasis is placed on *** p<0.01 (Significant at 1 percent level), ** p<0.05 (Significant at 5 percent level) and * p<0.10 (Significant at 10 percent level).*

The findings contained in Following the confirmation of the existence of cointegration between LNFDI, LNGDP and LNICTI, the Granger causality test was undertaken to determine the direction of causality.

Table 5-35 indicate the rejection of two null hypotheses - LNICTI does not Granger cause LNFDI at the 10 per cent significance level, and LNICTI does not Granger cause LNGDP at the 5 per cent significance level. Therefore, it could be concluded that:

- ICT infrastructure Granger causes FDI.
- ICT infrastructure Granger causes economic growth.

To that extent, unidirectional causality exists from LNICTI to LNFDI and from LNICTI to LNGDP.

Table 5-36: Summary ARDL Cointegration Test Results

Dependent Variable	Independent Variables	Optimal Lag Length	AIC	Trend Term	Overall F-statistic	t-statistic	Conclusion
LNFDI	LNGDP, LNINFR, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	(3, 0, 3)	2.885229	Insignificant	12.89992***	-6.163532***	Cointegrated
LNGDP	LNFDI, LNINFR, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	(4, 0, 0)	0.328712	Insignificant	13.34664***	-5.922322***	Cointegrated
LNINFR	LNFDI, LNGDP, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	(1, 1, 1)	-2.246309	Insignificant	2.797323	-2.850483	No-cointegration
LNFDI	LNGDP, LNENEI, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	(1, 0, 0)	3.122382	Insignificant	20.54022***	-7.717582***	Cointegrated
LNGDP	LNFDI, LNENEI, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	(4, 0, 0)	-0.345174	Insignificant	13.75075***	-6.411354***	Cointegrated
LNENEI	LNFDI, LNGDP, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	(2, 0, 0)	-2.386534	Insignificant	4.863706**	-3.921712**	Cointegrated
LNFDI	LNGDP, LNTRAI, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	(2, 0, 2)	3.090763	Insignificant	14.17967***	-6.500648***	Cointegrated
LNGDP	LNFDI, LNTRAI	(2, 2, 3)	-0.166914	Insignificant	14.25233***	-6.510749***	Cointegrated

LNTRAI	LNFDI, LNGDP, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	(3, 0, 0)	-3.214899	Insignificant	1.585284	-0.805690	No-cointegration
LNFDI	LNGDP,LNWATI, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	(2, 0, 3)	3.014744	Insignificant	17.28363***	-7.109321***	Cointegrated
LNGDP	LNFDI, LNWATI, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	(4, 0, 0)	-0.381843	Insignificant	14.67519***	-6.406317***	Cointegrated
LNWATI	LNFDI, LNGDP, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	(1, 2, 2)	0.965343	Insignificant	9.018606***	-3.553950**	Cointegrated
LNFDI	LNGDP, LNICTI, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	(2, 0, 1)	2.915500	Insignificant	17.00669***	-7.100889***	Cointegrated
LNGDP	LNFDI, LNICTI, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	(3, 2, 3)	-0.319297	Insignificant	9.307375***	-5.257620***	Cointegrated
LNICTI	LNFDI, LNGDP, LNOPN, LNINFL, LNEXC, LNCRD, LNLAB	(2, 1, 0)	-1.706648	Significant**	6.457054**	-4.525272**	Cointegrated

*Parenthesis () contains the probability values of the F-statistic. Emphasis is placed on *** $p<0.01$ (Significant at 1 percent level), ** $p<0.05$ (Significant at 5 percent level) and * $p<0.10$ (Significant at 10 percent level).*

5.3.3 Cointegration and Study Hypotheses Test Results Summary

The findings in Table 5-36 show that FDI, infrastructure and economic growth are generally cointegrated.

Table 5-37: Summary of Significant Results – Long-run and Short-run Relationships and Granger Causality

Equation	Output Variable	Main Independent Variables	Relationship	Coefficient (Probability)	Granger Causality Test Results
1.	LNFDI	LNINFR	Long-run	4.221877*** (0.0000)	• Infrastructure Granger causes FDI
		D(LNINFR(-1))	Short-run	6.809679*** (0.0094)	
3.	LNINFR	LNFDI	Long-run	0.057512 (0.1979)	• FDI Granger causes infrastructure development
		D(LNGDP(-2))	Short-run	0.105629** (0.0114)	
6.	LNENEI	LNFDI	Long-run	-0.028935 (0.2174)	• FDI Granger causes energy infrastructure development
7.	LNFDI	LNTRAI	Long-run	3.733869** (0.0171)	• FDI Granger causes transport infrastructure development
8.	LNGDP	LNTRAI(-3)	Short-run	1.770727** (0.0417)	• Economic growth Granger Causes transport infrastructure development
10.	LNFDI	LNWATI	Long-run	0.832591*** (0.0020)	• Water infrastructure development Granger causes FDI*
12.	LNWATI	D(LNFDI(-1))	Short-run	0.169126*** (0.0002)	
		D(LNGDP(-1))	Short-run	0.272500** (0.0190)	• FDI Granger causes water infrastructure development

13.	LNFDI	D(LNICTI)	Short-run	-3.813055*** (0.0009)	• ICT Infrastructure Granger causes FDI
14.	LNGDP	D(LNICTI(-1))	Short-run	-0.952607*** (0.0097)	• ICT infrastructure Granger causes economic growth
		LNICTI(-2)	Short-run	1.382684** (0.0310)	

(***) Significant at 1 per cent, (**) Significant at 5 per cent, and (*) Significant at 10 per cent.

The long-run and short-run relationships and Granger causality test results summarised in Table 5-37 confirm the validity of the following study hypotheses. The study hypotheses are restated, and the findings of the tests are discussed.

(i). Infrastructure Granger causes FDI

It is important to remember that the main research objective is to study the effect of infrastructure on FDI and its relation to economic growth in Kenya. This relationship is summarised in the paragraphs that follow. In the meantime, the study hypothesis is verified when Granger causality is tested for the relationship between FDI, GDP and INFR; FDI, GDP and WATI; and FDI, GDP and ICTI. Hence, this result applies to the effect on FDI emanating from the combined infrastructure (INFR), water infrastructure and ICT infrastructure. The outcomes indicate that infrastructure Granger causes FDI.

The findings from the long-run ARDL bounds cointegration test indicate that at the 1 per cent significance level, infrastructure (composite index) has a statistically significant positive causal impact on FDI. A 1 per cent increase in infrastructure investment gives rise to 4.22 per cent expansion in FDI. The short-run results from the error correction model reveal that a 1 per cent expansion in the one-period lag of infrastructure leads to a 6.81 per cent expansion in FDI. The long-run and short-run results are significant at the 1 per cent significance level.

The short-run relationship findings from the analysis of the relationship between FDI, GDP and ICTI show that a 1 per cent increase in investments in ICT lead to a 3.81 per cent decrease in FDI inflows. The impact of ICT infrastructure is significant at the 1 per cent significance level. However, water infrastructure positively influences the FDI inflows. In the long-run, a 1 per cent increase in water infrastructure may lead to a 0.83 per cent rise in FDI. The result is significant at the 1 per cent significance level.

The finding that infrastructure positively affects FDI agrees with other studies. Broyer and Gareis (2013) study showed that a rise in investment towards public infrastructure is linked to higher output, a rise in private investment and increased employment. Bakar *et al*. (2012) study found that infrastructure was significant and affected FDI inflows positively. Ansari *et al*. (2010) study revealed decreases in transactional and transportation costs as development is made on physical infrastructure. To that extent, infrastructure investments enhance activities of the private sector by reducing costs of production, opening new markets, providing new opportunities for production and trade (Siyal *et al.*, 2016).

The negative effect of ICT infrastructure on FDI aligns with Asongu and Odhiambo (2019) study, which found ICT (mobile connectivity) negatively influences FDI and economic growth when it exceeds certain investment thresholds. Asongu and Odhiambo (2019) recommended using productive complementary policy initiatives to make ICT investments that exceed the required threshold to have a positive impact. Such complementary policy initiatives include enhanced financial access, improvement of human resources and institutional development.

(ii). Economic growth does not Granger cause FDI.

The Granger causality test does not show GDP Granger causing FDI in any of the models regressed. The long-run and short-run results do not show any statistically significant impacts of GDP on FDI. The result of this study means that economic growth does not lead to the attraction of FDI to Kenya.

The finding that economic growth does not have a significant effect on FDI inflows is against findings of past literature. Several studies have shown that economic growth has a positive impact on FDI inflows. Okafor *et al.* (2017) found that FDI inflows into SSA region are influenced by GDP per capita. Almfraji and Almsafir's (2014) review of several types of research showed that FDI and economic growth relationship was positive. Pradhan *et al.* (2013) study revealed that economic growth positively impacted FDI. Fischer (1992) found a positive association between economic growth and investment rate of FDI in SSA and Latin America and the Caribbean (LAC) countries. Other studies have found a negative impact of economic growth on FDI inflows. Owusu-Manu *et al.* (2019) and Sarker and Khan (2020) found a negative impact of economic growth on FDI. Kwoba and Kibati (2016) found a negative but insignificant effect of GDP on FDI.

(iii). Infrastructure Granger causes economic growth.

The outcomes from the Granger causality test show that water infrastructure expansion Granger causes economic growth. The error correction and short-run model analyses reveal that transport and ICT infrastructure impact economic growth. In the short-run, transport (road) infrastructure has a positive and statistically significant causal effect on economic growth. A 1 per cent rise in the three-period lag of transport infrastructure may raise economic growth by 1.77 per cent. The result is statistically significant at the 5 per cent level.

The ICT infrastructure in the short-run has significant negative and positive causal effects on economic growth. The one-period lag of ICT infrastructure has a statistically significant negative impact on economic growth. In contrast, the two-period lag of ICT infrastructure has a positive and statistically significant effect on economic growth. The two impacts on economic growth from ICT infrastructure are statistically significant at the 1 per cent and 5 per cent significance level, respectively. However, the net effect from ICT on economic growth is positive where the effect from the one-period lag (-0.95) is overshadowed by the two-period lag (1.38).

The study findings concur with other studies that show that infrastructure indirectly or directly affects economic growth. Gherghina *et al.* (2019) contend that information technology, and transport infrastructure, among others, are important drivers of economic growth. Mbulawa's (2017) study found that the growth of the economy in the long-term is explained by infrastructure including roads maintenance. Serdaroğlu (2016) found that total public infrastructure capital investment is key to enhancing economic growth. Siyal *et al.* (2016) discovered a uni-directional association existing between infrastructure investment and economic growth.

(iv). FDI Granger causes infrastructure development.

The null hypothesis that FDI does not Granger cause infrastructure development was rejected while analysing the relationship between FDI, GDP and INFR; FDI, GDP and ENEI; FDI, GDP and TRAI; and FDI, GDP and WATI. In one of the positive results, a 1 per cent rise in the one-period lag of FDI may lead to a 0.17 per cent rise in water infrastructure development. This short-run impact by FDI to water infrastructure is statistically significant at the 1 per cent significance level.

Other previous studies have confirmed the significant effect of FDI in infrastructure development. FDI provides funds for investment in infrastructure development. Agbola (2014) contends that FDI represents a prime supply of external financing for developing countries.

Belloumi (2014) argues that inward FDI can play a pivotal part in the offshore market by expanding and supporting the provision of funds for investment in the domestic economy. Pradhan *et al.* (2013) found that FDI can be beneficial in a country if it is used in the construction of roads, railways, communication infrastructure, and other important growth-oriented infrastructure.

(v). Economic growth Granger causes infrastructure development

The long-run and short-run regressions confirm that economic growth has a causal effect on infrastructure development. Economic growth has a statistically significant impact on infrastructure development as shown in the equations where infrastructure index (INFR), and water infrastructure are the output variables.

The ARDL error correction and short-run model regression results show that economic growth has a short-run causal impact on infrastructure (INFR) and water infrastructure. From the analysis, results show that a 1 per cent change in the two-period lag of economic growth may result in a 0.11 per cent change in the same direction in infrastructure investment. Likewise, a 1 per cent change in the one-period lag of economic growth results in water infrastructure development changing in the same direction by 0.27 per cent. The impacts on INFR and water infrastructure are statistically significant at the 5 per cent significance levels.

The long-run and short-run study results collaborate with the outcomes of previous studies. Mbulawa's (2017) study found that economic growth has a positive impact on infrastructure development. Pradhan and Bagchi's (2013) study findings revealed that economic growth positively impacts road transportation infrastructure. Pradhan *et al.* (2013) found that economic growth had a positive causal influence on infrastructure development. Snieska and

Simkunaite's (2009) study found that in Latvia and Estonia, telecommunication and transportation sectors link strongly with economic growth and in a positive direction.

(vi). FDI does not Granger cause economic growth

The study findings at least at the 10 per cent significance level could not lead to the rejection of the null hypothesis that FDI does not Granger cause economic development. The long-run and short-run regression analysis results do not show any significant effect from FDI on economic growth. This suggests that the postulation that the Kenyan economy may develop through FDI inflows has to be toned down.

The findings from other studies show that FDI Granger causes economic growth. Almfraji and Almsafir (2014) reviewed several types of research that looked at the impact of FDI on economic growth between 1994 and 2012. The review showed that FDI directly and indirectly affected economic growth. Gherghina *et al*.'s (2019) study revealed a short-run uni-directional causal effect from FDI to growth and a long-run bi-directional causal relation between FDI and growth. Waikar *et al.* (2011) showed that FDI had a positive effect on economic growth and per-capita income. Agbola (2014) found that FDI had a positive impact on the economy's growth.

Belloumi's (2014) study found no significant Granger causality from FDI to economic growth and vice versa. Owusu-Manu *et al.*'s (2019) study on the short-run effect of FDI on the economy of Ghana disclosed a negative and significant relationship between FDI and GDP.

5.3.4 Other Impacts on FDI, Economic Growth and Infrastructure Development

The inclusion of control variables in the analysis of the relationship between FDI, economic growth and infrastructure development gave results that showed significant impacts.

The findings from the ARDL model regression, error correction models and short-run regression analysis show that market openness has statistically significant positive impacts on FDI. In addition, the findings further revealed that the exchange rate and labour resources negatively influenced FDIs. Market openness boosts FDI inflows, while exchange rate and labour force negatively influence FDI inflows in Kenya in the short-run.

The findings of the analysis additionally reveal that market openness and labour resources have a positive effect on economic growth. The rate of inflation and exchange rate have negative effects on economic growth.

The empirical analysis results show that the labour force and market openness have a positive effect on infrastructure development in the short-run. The positive effect of labour resources is shown in the equations where INFR and energy infrastructure are the regressands. Market openness has a positive impact on water infrastructure development. The exchange rate has a negative effect on infrastructure development. This was revealed in the equation where transport and water infrastructure were the dependent variables.

5.4 Chapter Summary

This chapter gives the findings of the analysis of the econometric models formulated under the research methodology in chapter four. Data analysis and unit root tests are conducted in readiness for the empirical analysis. The variables identified under the research methodology are restated, and the infrastructure composite variable was generated through the PCA method. All data were transformed to logarithms before the analysis was done to capture the time series proliferative effect. Then, the descriptive analysis was undertaken to observe the behaviour of the data.

The plots of the time series data over time are done to check on the applicability of the constant term and the deterministic trend while undertaking the unit root and the empirical tests. The unit root tests are performed to ascertain the order of integration where the outcomes show that the variables are mixed between I(0) and I(1), and therefore, ARDL bounds test is selected as the appropriate method for the cointegration study. The variables time series properties are determined before the estimation of the research equations. This include the determination of optimum lag lengths and diagnostic tests of the time series model.

In specific terms, the testing of the properties of the time series data was undertaken to achieve estimation validity and reliability from the models of analysis. Where cointegration is established, respective ECM analysis is undertaken to determine the long-run dynamics (error correction) and the short-run causal effect of the regressors on the dependent variable. If no cointegration is determined to exist in the equation of analysis, a short-run model regression is carried out to determine the short-run causal effect of the regressors on the dependent variable. Finally, the Granger causality test is undertaken to test the study's null hypotheses.

The combined outcomes from the cointegration tests, error correction regression, short-run model regression, and Granger causality tests cannot reject five of the six study hypotheses. The study results meet the main research objective of determining the effect of infrastructure on FDI and its relation to economic growth in Kenya. The findings find that infrastructure Granger causes FDI. The study find that FDI, economic growth and infrastructure development are cointegrated in the long-run. In the long-run, a 1 per cent increase in infrastructure investment gives rise to 4.22 per cent expansion in FDI. This finding is statistically significant at the 1 per cent significance level.

The findings further find that infrastructure Granger causes economic growth and FDI Granger causes infrastructure development. The Granger causality results show that economic growth does not Granger cause FDI, and also FDI does not Granger cause economic development. The findings mean that economic growth does not lead to the attraction of FDI in Kenya and that the economy may not be developed through FDI inflows.

The study also determines that market openness, inflation rate, exchange rate, and labour resources have mixed impacts on FDI, economic growth and infrastructure. Market openness has a positive impact on FDI, economic growth and infrastructure development, while the exchange rate has a negative impact on the three variables. Labour resources positively influence infrastructure development, while it has a negative impact on FDI. The inflation rate has a negative effect on economic growth. The observed impacts from the control variables need to be considered when deriving policies aimed at encouraging FDI inflows, economic growth and infrastructure development in Kenya.

After the presentation of empirical findings where the research hypotheses are tested, and research questions answered, conclusions and policy directions are provided next in chapter six. In chapter six, suggested areas of possible future research are also presented.

CHAPTER SIX
CONCLUSIONS AND POLICY DIRECTIONS

6.1 Introduction

The research investigates the relationship between FDI, economic growth and infrastructure development in Kenya for the 1970-2019 period. The analyses of econometric models that had been specified in chapter 4 are performed in chapter 5. The analyses conducted include cointegration tests, long-run relationships, ECM analysis, short-run coefficient analysis, and Granger causality tests. The analyses are conducted among the variables of the study comprising of FDI, economic growth and infrastructure development. Identified control variables that literature showed had an influence on FDI were also included. Inferences are drawn from the findings of the models' analyses by singling out statistically significant outcomes, emphasising on the findings that were of statistical significance at the 1 per cent and 5 per cent significance levels. The outcomes of the analysis lead to the achievement of the research objectives, including the determination of the validity of the stated study hypotheses.

Chapter six summarises study findings, pinpoints policy implications, the contribution of the study to knowledge, and gives recommendations and possible areas that can be researched in the future according to conclusions drawn from the study analyses and findings.

6.2 Summary of Findings

The main study objective is to empirically investigate the effect of infrastructure on the attractiveness of Kenya to the inflow of FDI. The study further investigates the effects of FDI inflow on economic growth in Kenya. This lead to the understanding of the interrelationship between infrastructure development, FDI inflows, and economic growth.

The objective of the study lead to the formulation of the research hypotheses, which the study seek to test and verify. The study hypotheses are:

H1: Infrastructure Granger causes FDI.

H2: Infrastructure Granger causes economic growth (GDP).

H3: FDI Granger causes Infrastructure development.

H4: FDI Granger causes economic growth (GDP).

H5: Economic growth Granger causes FDI.

H6: Economic growth Granger causes infrastructure development.

The findings from the tests of unit root reveal that the variables of analysis are either of order one I(1) integration or zero I(0) integration. This finding give rise to the decision made in the study to utilise the ARDL bounds approach in determining the variables cointegration. After determining the existence of cointegration, the set of equations found to have cointegration are subjected to error correction regression to determine the long-run dynamics (error correction) and the short-run causal effect of the explanatory variables on the dependent variable. When no cointegration is determined to exist in the equation of analysis, a short-run model regression is carried out to determine the short-run causal effect of the regressors on the regressand. Lastly, the Granger causality test is undertaken to test the study's null hypotheses.

From the analysis, most ARDL cointegration outcomes show that infrastructural development, inflow of FDI, and economic growth are cointegrated, denoting that a long-run equilibrium relationship exists between the three main variables of the study. The main study variables are infrastructure (INFR), inflow of FDI, and economic growth. The research further reveal that the decomposed (individual) infrastructure sub-sectors (energy, transport, water and ICT), inflow of FDI, and economic growth are cointegrated. The long-run relationship between the study variables is reiterated by the ECM results, which show the reversion of the systems toward the long-run equilibrium following short-run shocks. The Granger causality tests unveil the existence of either unidirectional, bidirectional or no causality among some of the variables of the study. The combined results from the study fail to reject four of the six study hypotheses. The findings conclude that infrastructure Granger causes inflow of FDI, infrastructure Granger causes economic growth, FDI Granger causes infrastructure development, and economic growth Granger causes infrastructure development. The findings cannot conclude whether economic growth Granger causes FDI, nor that FDI Granger causes economic growth.

The empirical study results can be summarised as follows:

(i). ***Infrastructure Granger causes FDI***

The infrastructure development (composite index – INFR) has significant short and long-run effects on FDI. The findings also show that transport and water infrastructure positively influence FDI inflows in the long-run. In the short-run, ICT infrastructure negatively impacts FDI.

The empirical evidence obtained from this study corresponds with other previous studies. Studies that found that infrastructure positively affects FDI include Broyer and Gareis (2013), Bakar *et al*. (2012), and Ansari *et al*. (2010). Broyer and Gareis' (2013) study revealed that increased public infrastructure (transport) investment leads to higher output, private investment, and employment. Bakar *et al*.'s (2012) study found that infrastructure was significant and affected FDI inflows positively. Ansari *et al*. (2010) study revealed decreased transactional and transportation costs as development is made on physical infrastructure. To that extent, infrastructure investments enhance activities of the private sector by reducing costs of production, opening new markets, providing new opportunities for production and trade (Siyal *et al.*, 2016).

It is however, important to note that some studies have had mixed results on the impact of infrastructure on FDI. For instance, Gholami, *et al.* (2003) could not find significant causality from ICT to FDI in developing countries. They contend that the ICT capacity must be built up to attract FDI in developing countries. Ogunjimi (2019) found that telephone lines and electricity did not have an impact on FDI in the short-run. Electricity, however, influenced FDI in the long-run. The negative effect of ICT infrastructure on FDI aligns with Asongu and Odhiambo's (2019) study, which found that ICT (mobile connectivity) negatively influence inflow of FDI.

(ii). ***Infrastructure Granger causes economic growth***

The Granger causality test shows that expansion of water infrastructure Granger causes economic growth. The error correction and short-run model analyses reveal that transport and ICT infrastructure impact economic growth. In the short-run, transport (road) infrastructure has a positive and statistically significant causal effect on economic growth. The ICT infrastructure in the short-run has significant both negative and positive causal effects on economic growth, where the net effect is positive.

The study findings agree with other studies that established both direct and indirect causal relationships between infrastructure economic growth. For instance, Gherghina *et al.*'s (2019) showed a positive effect of information technology and transport infrastructure on economic growth. Furthermore, Mbulawa (2017) found that the growth of the economy in the long-term is explained by infrastructure, including roads maintenance. Serdaroğlu (2016) found that infrastructure positively enhances economic growth. Siyal *et al.* (2016) discovered a uni-directional association between infrastructure investment and economic growth.

(iii). ***FDI Granger causes infrastructure development***

The outcomes of the study also reveal that FDI Granger causes infrastructure development (INFR, water and energy). FDI has a positive long-run causal effect on infrastructure development (composite index – INFR). The findings suggest that inflow of FDI also influences investment in water infrastructure positively in the short-run. Furthermore, FDI influences ICT infrastructure positively and negatively in the short-run, with a positive net effect. The long-run effect of FDI on ICT infrastructure is positive but statistically insignificant.

Previous studies have similarly established that a positive causal effect flows from inflow of FDI to infrastructure development. These studies include Agbola (2014), Belloumi (2014) and Pradhan, *et al*. (2013).

(iv). ***Economic growth Granger causes infrastructure development***

The findings of the study show that economic growth has a short-run positive causal impact on the infrastructure index (INFR) and water infrastructure. Previous studies that found that economic growth has a positive impact on infrastructure development include Mbulawa (2017), Pradhan *et al.* (2013), Pradhan and Bagchi (2013) and Snieska and Simkunaite (2009).

(v). ***Unconfirmed Hypotheses***

Two of the study hypotheses cannot be supported by data for Kenya. The two hypotheses are – economic growth Granger causes FDI and FDI Granger causes economic growth. The findings imply that economic growth does not lead to the attraction of FDI inflows in Kenya. Also, FDI inflows do not affect the rate of economic growth in Kenya.

The causality results between FDI and economic growth diverge from other previous findings. Gherghina et al. (2019) found that in the long run there is a bi-directional causal link amongst FDI inflows and growth. FDI inflows into Sub-Saharan Africa region is influenced by GDP per capita and infrastructure development, among other variables (Okafor et al. 2017). Almfraji and Almsafir (2014) review of several types of research showed that FDI and economic growth relationship was positive. Pradhan *et al.* (2013) study revealed a two-way causality existing among FDI and economic growth, where economic growth had a positive impact on foreign direct investment. Fischer (1992) found a positive association between investment rate of FDI in sub-Saharan African (SSA) and Latin America and the Caribbean (LAC) countries. Gilmore *et al.* (2003) reveal that FDI inflow to a country is determined by factors such as the growth of the host market, costs of transport, technology, and infrastructure.

Several studies have found no causality existing between FDI and economic growth. Coban and Yussif (2019) and Frimpong and Oteng-Abeyie (2007) found no causality between FDI and economic growth in Ghana. Agbola (2014) study of Philippines found that FDI does not Granger cause economic growth, and vice versa. Chakraborty and Basu (2002) examination of causality between FDI and output growth in India found FDI does not Granger-cause real GDP. FDI does not exert a significant and positive impact on economic growth in developing countries (Carkovic and Levine, 2005).

(vi). ***Other results***

The study includes control variables during the examination of the relationship between infrastructure development, inflow of FDI, and economic growth. The study find that market openness has a positive impact on FDI inflows to Kenya, while labour force and exchange rates have negative impacts. Additionally, market openness and labour resources have positive effects on economic growth. The rate of inflation and exchange rate have negative effects on economic growth.

The findings of the analysis further show that labour force and market openness have positive effects on infrastructure development. Furthermore, market openness has a positive impact on water infrastructure development. The exchange rate has a negative effect on infrastructure development.

The proposed study hypotheses and the actual effects as revealed by the study outcomes are tabulated in Table 5-1.

Table 6-1: Hypotheses and Determined Effects

	Dependent Variable	**Determinant**	**Hypothesized Effect**	**Actual effect (Causal)**
1	FDI	Infrastructure	Positive	Positive
		Economic Growth	Positive	inconclusive
2	Economic Growth	Infrastructure	Positive	Positive/negative
		FDI	Positive	inconclusive
3	Infrastructure	Economic Growth	Positive	Positive
		FDI	Positive	Positive/negative

6.3 Policy Implications

The findings from the study are beneficial to policymakers. Policymakers are urged to promulgate policies that will promote:

(i) Infrastructural development

Infrastructural development has largely a significant positive causal effect on FDI and economic growth. For government to ensure continued inflows of FDI and to maintain sustainable economic growth into the future, it is considered important to focus on investing in infrastructure development. Therefore, improvement of transport and ICT systems and provision of sustainable energy and water resources are necessary for the government to attract FDI to Kenya.

The main stumbling block to infrastructure development as suggested by the review of literature is lack of adequate funding to undertake priority government projects. The government should create a good relationship with development partners including strategic PPPs initiative in a way that will not lead to strained public finances in order to undertake important infrastructure projects.

The findings of the study further reveal that ICT infrastructure has negative effects on inflow of FDI and economic growth in the short-run. The negative influence is thought to happen when investment in ICT infrastructure exceed certain investment thresholds. The investment in telephone connectivity in Kenya might be exceeding the required threshold. Although, the threshold analysis was beyond the scope of this thesis. The threshold observation was however, corroborated in the literature review where it was uncovered that growth in public infrastructure investment at first raises the rate of economic growth but cause it to fall beyond a certain threshold (Barro, 1990). It was also documented in literature that economic impact arising from infrastructure investment has a diminishing marginal rate of return (Rodrigue, 2020).

Asongu and Odhiambo (2019) recommend using productive complementary policy initiatives to make ICT investments that exceed the required threshold to impact economic growth positively.

This study has revealed further that market openness and labour resources have positive impacts on infrastructure development. Furthermore, exchange rate has a negative effect on infrastructure development in Kenya. As such, complementary policy initiatives that can make ICT investments to impact economic growth positively may include an appropriate regulatory framework, macroeconomic stability, improvement of human resources, and institutional development. The government should seek to promote macroeconomic stability by engaging in activities that prevent notable and sustained exchange rates volatility. The Central Bank of

Kenya (monetary authority) should continue instituting inflation targeting policies to control the fluctuation in the price level and other macroeconomic variables that may directly affect the exchange rate. Government should also implement other macroeconomic policies that may help to reduce prevalence of exchange rate volatility.

Rodrigue (2020) contends that the degree of infrastructure development and its quality and efficiency determine its overall impact on the economy. The impact is much lower when the infrastructure is already adequate, as maintenance of the efficiency of the infrastructure requires minimal investments. Arising from this observation, government should prioritise maintenance of developed infrastructure to ensure that its quality and efficiency is sustained. Funds allocated to the maintenance of infrastructure, especially ICT infrastructure, need to be sustained concurrently. Furthermore, the environment conducive to the participation of the private sector in infrastructure development and maintenance should be promoted by the government. Moreover, there is a need to ensure that the PPP and other investment laws effectively promote and encourage private players in a mutually benefiting manner, to sustain investments in infrastructure.

(ii) Economic growth

Economic growth has a positive causal impact on infrastructure (composite index), and more specifically, water infrastructure in the short-run. As a result, it can be asserted that economic growth is an important factor for infrastructure development in Kenya. Efforts to grow the economy and help infrastructure development should be encouraged. However, policy interventions that targets short-run growth effects should be promulgated in order to catalyse infrastructural development. Policies that aim to grow the economy at all costs, in the long-run, will not help in the much-needed infrastructure development investments.

However, it should be noted that the impact of economic growth is augmented by several other factors such as market openness and labour resources. Government should promulgate policies to encourage more players to participate in the economy through liberalisation efforts.

(iii) Attract FDI inflows

The study has shown that FDI has a positive causal effect on infrastructure development. FDI is therefore a good policy variable to predict investments in infrastructure. To ensure that the impetus of infrastructure development is sustained, policies that promote FDI inflows should be encouraged by the Government of Kenya.

The study show that market openness, exchange rate and labour resources influence FDI in Kenya. Incorporation of more FDI growth-influencing policies should be encouraged. Institutional development and an effective regulatory framework will open up the economy for participation by more investors and therefore promote inflow of FDI. On the other hand, policies geared towards improving the quality of human resources and labour skills should be encouraged. Since FDI is increasingly associated with modern technologies, highly skilled labour should be promoted to use modern technology and create a positive technological diffusion effect. At the same time, other than prioritising the attraction of FDI, government should enhance FDI by looking into policies on human capital and macroeconomic stability (inflation rate and exchange rate stability). This will enhance the absorption of the maximum FDI benefits.

6.4 Contributions to Knowledge

The study augments the body of existing knowledge on the role of infrastructure development on the attractiveness of countries to inflow of FDI, the relationship between inflow of FDI and economic growth, as well as between infrastructure development and economic growth, with specific focus on Kenya. The main research objective was to empirically investigate the effect of infrastructure on the attractiveness of Kenya to the inflow of FDI.

The study finds that infrastructure (INFR) Granger causes FDI. In the long-run, a 1 per cent increase in infrastructure investment may lead to a 4.22 per cent increase in inflow of FDI. The result is statistically significant at the 1 per cent significance level. The analysis further reveal that specific infrastructure sub-sectors have a discernible effect on FDI. In specific, transport and water infrastructure have statistically significant positive effects on inflow of FDI to Kenya. However, ICT infrastructure in the short-run negatively influences inflow of FDI into Kenya, which is converse to findings in a few previous studies (see Nguea, 2020; Demirhan and Masca, 2008; and Kirkpatrick *et al*., 2006). Gholami, *et al.* (2003) could not find significant causality from ICT to FDI in developing countries. Asongu and Odhiambo's (2019) study found a negative effect of telephone connectivity on FDI, which they argued might be associated with telephone connection penetration being saturated (attained threshold) in the economy. They observed that the ICT variables have differing penetration potential and hence their effect on FDI is different.

The study is also a first in examining the causal effect of FDI on infrastructure development in Kenya. The findings from the study show that FDI Granger causes infrastructure development in Kenya. FDI has a positive long-run causal effect on infrastructure development (composite index – INFR). On the findings of the impacts of the individual infrastructure sub-sectors, FDI influences investment in water infrastructure positively in the short-run. The study results collaborate those of other countries (see Agboola, 2014; Belloumi, 2014; Pradhan, *et al*., 2013).

The study utilised the composite infrastructure index (created through the PCA method), and individual infrastructure variables (transport - roads, energy – electricity, water – government expenditure on water and ICT – telephony connections) to examine the causal relationship with both FDI and economic growth. The use of the composite index is rare, while system equation estimation of individual explanatory variables as deployed in this study is uncommon. Infrastructure has been represented by a single variable in previous studies when being studied together with FDI. Infrastructure was represented by electricity in Owusu-Manu *et al.* (2019), government expenditure in Bakar *et al.* (2012) and telephone lines in Demirhan and Masca (2008). Nguea (2020) used three variables individually including telephone lines, electricity consumption and rail lines, while Kirkpatrick *et al*. (2006) used telephone lines and electricity in analysing the relationship between FDI and infrastructure. Our study is more representative of infrastructure since the impacts of the four main physical infrastructure variables (transport, water, energy and ICT) on FDI are tested separately, and as a combined index. The physical infrastructure leads to more pronounced, reliable and conclusive results than monetary measures (see Calderon and Serven, 2014). The PCA is used because dependable measures of particular coefficients of variables proxying various types of infrastructure are difficult to ascertain while using a linear regression framework because of the close association of different infrastructure categories (Calderon and Serven, 2004).

Therefore, the research provides information that explains the effect of the combined physical infrastructure and that of individual infrastructure sub-sectors both in the short and long-run. By using this method, diverse knowledge is provided, which may inform policy directives on augmentation of infrastructure as a driver of FDI inflows, as well as economic growth in Kenya. No previous study on Kenya has attempted to study such a combination of infrastructure variables together, and such studies are rare in documented studies on African continent.

Two of the study hypotheses cannot be determined for the case of Kenya. The study findings fail to confirm that economic growth Granger causes FDI, and FDI Granger causes economic growth. The findings imply that economic growth does not lead to the attraction of FDI inflows in Kenya. Also, FDI inflows do not affect the rate of economic growth in Kenya. The finding that economic growth does not have a significant effect on FDI inflows is against findings of past literature. Several studies have shown that economic growth has a positive impact on FDI inflows. Okafor *et al.* (2017) while doing panel data (fixed effects estimations) found that FDI inflows into SSA region are influenced by GDP per capita. Almfraji and Almsafir's (2014) review of several types of research of both developed and developing countries showed that FDI and economic growth relationship was positive. Pradhan *et al.* (2013) study of India revealed that economic growth positively impacted FDI. Fischer (1992) found a positive association between economic growth and investment rate of FDI in SSA and Latin America and the Caribbean (LAC) countries. Owusu-Manu *et al.*'s (2019) study for Ghana and Sarker and Khan's (2020) study of Bangladesh found a negative impact of economic growth on FDI.

Coban and Yussif (2019) and Frimpong and Oteng-Abeyie (2007) studies found no causality between FDI and economic growth in Ghana. Agbola (2014) study of Philippines found that FDI does not Granger cause economic growth, and vice versa. Chakraborty and Basu (2002) examination of causality between FDI and output growth in India found FDI does not Granger cause real GDP. Carkovic and Levine (2005) revealed that FDI does not exert a significant and positive impact on economic growth in developing countries.

For the FDI inflows to positively affect economic growth, there is a need for technological spillovers emanating from adopting new technologies in the production process. Furthermore, FDI needs to stimulate knowledge transfers by introducing new management practices, skills acquisition, labour training and better organisational arrangements. On the other side, economic growth will impact FDI inflows if there is a conducive environment to do business, including the availability of cheap and reliable inputs. More studies need to be undertaken to determine how FDI inflows support the adoption of new technologies in Kenya and how far it is promoting knowledge transfers.

It may however, be important to point out that the ratio of FDI inflows to Kenya is relatively weak considering the size of its economy. Furthermore, Kenya doesn't fare well as an FDI destination compared to other developing countries, especially in Africa. The FDI net inflows (% of GDP) to Kenya is 1.4 per cent compared to an average of 1.8 per cent in SSA, and an average of 1.9 per cent in the world (The World Bank, 2021).

Furthermore, the type and depth of FDI required to support economy growth may be considered inadequate in Kenya, especially as compared to the other developing countries. Kenya's share of manufacturing value-added to GDP is 8 per cent, which is well below the sub-Saharan average of 12 per cent, and the world average of 16 per cent (The World Bank, 2021). To improve the contribution of FDI inflows to economic growth, Kenya needs to put in place policies that will attract investors who engage in value addition investments into the country. Chen, *et al* (2015) assert that FDI in the services sector is dominant compared to investment in the manufacturing sector. These authors further opine that manufacturing FDI in Africa is undiversified and focuses only on raw material (food) processing and to some extent end-product assembly. Raw material processing and assembly of end-product have low-value addition that renders FDI inflows ineffective in contributing to economic growth.

In specific, Kenya needs to create conducive policies to attract value-adding FDI such as those that engage in manufacturing, which in turn could lead to more employment, exports of finished products, and support formal training and technological transfers. FDI is attracted into a country if friendly protective regulations to manage markets are adopted, the openness of the economy is ensured, trade interventions are minimised, exchange rate interventions are minimised, there is low corruption, rule of law is supreme, and there is transparency (Popovici and Calin, 2014). Similarly, Carbonell and Werner (2018) contend that for countries to enhance growth, technology transfer from abroad through FDI should be encouraged. In this way, FDI will play the required role of supporting economic growth.

The study also utilises a combination of the ARDL bounds approach, VECM and Granger causality test to investigate the relationships between infrastructure, inflow of FDI, and economic growth. No other documented study is available that has ascertained the relationship existing among infrastructure, FDI and economic growth in Kenya using the ARDL bounds technique, VECM and Granger causality test.

This study departs greatly from documented studies not only on the robust variables under consideration, but also on methodology and scope (see Wekesa, *et al*., 2016; Kwoba and Kibati, 2016; Nyaosi, 2011; and Muthoga, 2013). Recent studies have opted to utilise only the ARDL bounds cointegration testing approach to investigate the relationship among some of the variables under investigation in this study, but not all the variables (see Egbetunde and Fasanya (2014), Belloumi (2014), Pradhan *et al.* (2013)).

More importantly, the ARDL bounds test allows the researcher to estimate the long-run and short-run parameters of the models simultaneously, which culminated in the determination of causality between variables of the study. The determination of the causality relationship between the study variables is useful for policy purposes and indicates where interventions can be made to accelerate FDI inflows, infrastructure investments and economic growth in Kenya.

6.5 Recommendations

The study indicates that infrastructure development and economic growth predict each other. Likewise, infrastructure development and FDI influences each other in Kenya. As such, policies that promote economic growth would ultimately be cardinal in ensuring that there is infrastructure development in Kenya. Furthermore, it is important to observe that infrastructure in Kenya is economically productive, as shown by the study findings. Infrastructure positively influences economic growth and FDI inflows. In addition, it is important to note that ICT infrastructure affects FDI negatively. To that extent, the long and short-run increase in public infrastructure investment may enhance growth and inflow of FDI but would also dissuade FDI inflows for the case of ICT infrastructure.

The private capital crowding-out effect and the antecedent negative effects emanating from infrastructure investment may happen when investment in infrastructure becomes too domineering in an economy (Shi *et al*., 2017). The findings of this study have determined that it may be healthy to continue investing in infrastructure to attract more FDI and for sustainable economic growth in Kenya, but investment in ICT (telephony connectivity) may be counterproductive. This is so especially in the face of ongoing huge debt exposure and its impending negative effects on the fiscus.

Factors that encourage investment in infrastructure may be encouraged, but to a limited extent. Appropriate infrastructure needs also be identified to ensure that it receives priority in the face of limited resources. Economic growth is enhanced when enough absorptive capacity created by infrastructure development still exists, among other variables.

Available infrastructure should also be utilised efficiently and protected from premature depletion for Kenya to reap the full benefits of the huge investment in infrastructure. Inefficient use of infrastructure may lead to payment of growth penalty in the form of a much smaller benefit from infrastructure investments. This implies that infrastructure must be used efficiently, and therefore, maintenance is important to ensure optimal utilisation. Lack of proper maintenance of infrastructure may lead to premature depletion of the infrastructure and may erode the effects of such a heavy investment on the attractiveness of the country to inflow of FDI.

Enough resources need to be provided to maintain infrastructure and prevent their destruction. Increasing maintenance spending will help to reduce power losses and outages, potholes on roads and so on and hence may help enhance the productivity effects of public infrastructure on economic growth and attraction into the country of FDI (see Agénor and Moreno-Dodson, 2006). More importantly, the protection of infrastructure from misuse and vandalism should be reinforced.

Infrastructure projects are expensive to construct and maintain. Government is the main financier through public funds. To ensure that more resources are attracted to develop infrastructure, other innovative funding mechanisms and alternative sources of funds such as PPPs may be encouraged to lessen the burden on the government that bears all the financing costs. The PPP may involve infrastructure management, financing, or ownership (part or whole). Exploiting opportunities in PPPs may involve attracting untapped funding sources into the sector, including pension and insurance funds, funding from the capital market (equity such as initial public offering and right issues, and bond market - infrastructure bonds and project bonds). When budget constraints are extremely tight, it is worthwhile to give priority to public spending that exhibits the greatest multiplier effects – in this case, drivers of economic growth.

To that extent, economic growth is found to be an important catalyst for increased infrastructure investments. Therefore, a conducive environment should be created to ensure that higher levels of economic growth are attained. As noted in the literature review, emphasis should be put on policy measures that expand R&D, education, skilled labour, improvement in technology, and infrastructure development as identified by the neoclassical's endogenous and exogenous growth theories. Spending on public goods such as education, healthcare and public transport may supports economic growth and development. Given the strong importance of economic growth from the analysis conducted in this study, policies should be geared towards creating a stable economic climate. Other possible drivers of economic growth (as suggested in the literature) are free market supply-side policies, including lower taxes, privatisation, deregulation, and fewer regulation to encourage private sector investment.

The study reveals that attracting more FDI to Kenya will promote infrastructure development. Policymakers will need to target factors that promote FDI inflows and address challenges that discourage FDI. The literature review shows that FDI in developing countries is influenced positively by infrastructure development (which conforms to the findings of this study), degree of openness to trade, presence of natural resources, business friendliness and labour cost. FDI inflows are also promoted by intangible assets such as entrepreneurial skills, information, technology, marketing, and management skills. Others include economic and political stability, opportunities for privatization, government emphasis on FDI and financial incentives, technology, costs of transport and infrastructure, and control of corruption (Okafor *et al*., 2017; Waikar, 2011; Gilmore *et al*., 2003). Corruption raises the costs of doing business and prevents FDI from contributing to human progress and development. Hence, FDI will tend to be attracted more to countries with higher institutional quality than than those with weak institutions (Gherghina *et al*., 2019). FDI inflows are impacted negatively also by the high inflation rate, high tax rate, and risk (Demirhan and Masca, 2008).

6.6 Conclusion

This study is a first for Kenya that has examined the relationship between FDI, infrastructure development and economic growth while applying the ARDL technique and VECM procedure. The ARDL cointegration outcomes show that the three variables are cointegrated, implying that they have a long-run relationship. Infrastructure has a positive causal effect on the inflows of FDI into the country. Similarly, FDI has a causal effect on infrastructure development. The study has revealed that infrastructural development and economic growth generally influence each other positively.

Therefore, although the Government of Kenya should continue to expend more in the development of infrastructure to attract more FDI inflows into the country, more efforts should be directed towards growing the economy in a sustainable way. Moreover, improvement in economic growth and increased FDI inflows would contribute to infrastructure development in Kenya. Policymakers should therefore ensure that the policies they enact are geared towards growing the economy in order to develop infrastructure, which further attracts inflow of FDI. The growth of FDI inflows in return supports infrastructure development.

6.7 Suggestion for Further Study

The study has determined that economic growth and infrastructure development influence each other, and there is bidirectional causality between infrastructure development and inflow of FDI. To ensure that policies devised to promote the development of FDI, economic growth and infrastructure are effective, there is a need to explore in-depth all the factors responsible for influencing each of these variables. This is so especially factors that influence FDI inflows in Kenya. The study showed that economic growth, infrastructure and the control variables (market openness, inflation, exchange rate, financial development, and labour resources) do not adequately explain FDI inflows (Adjusted $R^2 < 44\%$ in all the FDI dependent variables equations analysed). The in-depth exploration will ensure that policymakers formulate the right policies to enhance economic growth, achieve the inflow of FDI and improve infrastructure investments positively and effectively.

The findings reveal that development in ICT infrastructure reduces FDI inflows into Kenya. A positive relationship was expected since the level of infrastructure development in Kenya is still low. A further study is recommended to determine the cause of this relationship, especially if the ICT infrastructure development threshold (ICT penetration saturation levels) has been attained. Alternatively, analysis can be performed where ICT is represented by other proxies such as internet connectivity, software development, digital capacity, etc. Studies should also be undertaken to determine the infrastructure sub-sectors (energy, transport, water and ICT) development thresholds for Kenya and developing countries at large.

The study found no causality in Kenya between FDI inflows and economic growth. More studies need to be undertaken to determine the extent to which FDI is leading to adopting new technologies in Kenya and how far it is promoting knowledge transfers. Studies also need to gauge the Kenyan economy's conduciveness to attract FDI inflows.

There is little literature available on the effect of FDI on infrastructure development, especially covering the developing countries. This is an area that can be examined more to enrich the limited knowledge in this field.

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Appendix 1: Data used in the Empirical Analysis, 2000-2019

Year	GDP	FDI	INFR	ENEI	TRAI	WATI	ICTI	INFL	EXC	OPN	CRD	LAB
1970	-7.952	0.861	-1.214	153.21	2,936.00	56,114,584.97	35,538	2.18853	7.14286	0.723385	15.11892	126,855
1971	17.880	0.416	-1.155	186.13	3,102.60	70,777,450.17	39,510	3.78021	7.14286	0.654661	17.43253	140,722
1972	12.908	0.299	-1.075	190.83	3,339.90	98,184,749.48	43,775	5.83164	7.14286	0.48322	16.48605	161,910
1973	2.075	0.690	-0.983	202.53	3,714.30	124,933,304.17	42,515	9.28119	7.00119	0.471283	17.89332	174,767
1974	0.273	0.788	-0.879	266.01	4,022.40	148,328,832.04	45,515	17.80995	7.14286	0.532246	17.97643	195,800
1975	-2.823	0.526	-0.795	264.46	4,046.80	187,172,803.24	53,000	19.12018	7.34319	0.433348	17.33317	226,835
1976	-1.617	1.335	-0.709	330.09	4,044.90	213,385,543.66	57,000	11.44903	8.36714	0.423102	16.82708	280,388
1977	5.397	1.258	-0.250	338.74	4,376.30	414,709,653.05	62,400	14.82096	8.27656	0.425145	17.50860	319,982
1978	2.929	0.649	-0.446	460.84	4,330.50	297,750,783.89	65,300	16.93178	7.72938	0.455439	21.71203	361,622
1979	3.580	1.348	-0.732	463.91	5,335.90	125,350,424.77	69,700	7.97935	7.47531	0.369898	20.97326	384,389
1980	1.608	1.087	-0.612	468.06	5,541.80	173,175,462.24	73,900	13.85818	7.42019	0.377536	21.81178	419,201
1981	-0.159	0.206	-0.437	523.10	6,416.80	210,314,705.71	80,200	11.60305	9.04750	0.316414	21.00308	410,550
1982	-2.342	0.202	-0.684	538.10	6,409.90	91,548,845.83	88,100	20.66671	10.92232	0.292965	20.43702	438,424
1983	-2.513	0.397	-0.570	528.60	6,720.70	135,300,926.36	95,700	11.39778	13.31152	0.262767	19.32301	493,710
1984	-2.043	0.174	-0.576	542.10	6,720.70	129,421,838.08	106,100	10.28410	14.41387	0.277244	18.98640	502,146
1985	0.466	0.470	-0.560	542.10	6,730.70	136,573,513.70	118,361	13.00657	16.43212	0.268252	19.33408	437,207
1986	3.303	0.452	-0.530	542.10	6,730.70	150,378,899.18	129,453	2.53428	16.22574	0.281573	19.31199	458,712
1987	2.174	0.494	-0.700	542.10	6,924.10	63,530,535.90	137,505	8.63767	16.45449	0.280354	18.41642	522,261
1988	2.504	0.005	-0.593	686.10	7,686.80	53,766,818.30	151,964	12.26496	17.74710	0.281161	18.92614	540,192
1989	1.123	0.751	-0.639	705.60	7,686.80	27,931,168.47	162,894	13.78932	20.57247	0.294256	19.22448	640,735
1990	0.725	0.666	-0.382	705.60	7,900.00	140,147,331.54	175,050	17.78181	22.91477	0.322196	18.65653	618,461
1991	-1.859	0.231	-0.410	811.60	8,300.00	89,022,743.17	200,000	20.08450	27.50787	0.309566	19.95807	614,161
1992	-3.950	0.078	-0.337	804.10	8,700.00	110,063,087.65	207,442	27.33236	32.21683	0.307718	22.15245	629,062
1993	-2.757	2.532	-0.362	817.90	8,800.00	91,331,290.04	214,759	45.97888	58.00133	0.406018	18.49620	531,342
1994	-0.468	0.104	-0.192	820.80	8,800.00	170,455,904.60	228,522	28.81439	56.05058	0.418925	19.83416	619,839
1995	1.331	0.467	-0.207	791.10	8,800.00	169,422,468.27	256,434	1.55433	51.42983	0.414173	25.81412	632,388
1996	1.156	0.902	-0.278	788.80	8,660.00	142,090,517.56	266,780	8.86409	57.11487	0.410448	21.68163	658,253
1997	-2.347	0.473	-0.327	815.00	9,000.00	100,256,534.13	271,816	11.36185	58.73184	0.407095	24.35518	687,473
1998	0.440	0.188	-0.461	856.70	8,660.00	41,012,717.18	288,251	6.72244	60.36670	0.395196	23.96342	700,538

1999	-0.485	0.403	-0.421	930.20	8,660.00	43,428,106.63	313,760	5.74200	70.32622	0.398752	26.56944	724,758
2000	-2.125	0.873	-0.293	1,160.40	8,672.90	52,074,449.91	419,106	9.98003	76.17554	0.402542	25.75838	758,967
2001	0.987	0.041	-0.330	1,142.20	8,679.01	33,350,050.44	909,379	5.73860	78.56320	0.435033	25.22269	797,510
2002	-2.144	0.210	-0.268	1,142.20	8,685.10	56,476,667.07	1,508,602	1.96131	78.74914	0.417744	25.85460	819,227
2003	0.181	0.548	-0.183	1,142.20	8,688.43	92,457,478.83	1,919,148	9.81569	75.93557	0.41954	25.15568	882,513
2004	2.283	0.286	-0.194	1,198.10	8,752.06	63,775,723.75	2,845,255	11.62404	79.17388	0.448831	27.28752	926,150
2005	3.045	0.113	-0.054	1,156.60	8,780.49	118,837,849.58	4,765,729	10.31278	75.55411	0.475559	26.27688	934,149
2006	3.576	0.196	0.011	1,177.10	8,940.00	119,461,607.20	6,778,364	14.45373	72.10084	0.513207	22.88831	1,030,080
2007	3.933	2.281	0.090	1,196.60	9,011.24	120,627,064.14	9,768,766	9.75888	67.31667	0.505089	23.04496	1,180,267
2008	-2.503	0.266	0.320	1,267.90	9,079.04	173,642,063.48	13,580,356	26.23982	69.17583	0.545397	25.38061	1,382,211
2009	0.504	0.314	0.490	1,311.50	9,270.53	193,873,435.69	18,026,099	9.23413	77.35083	0.542533	25.02161	1,507,546
2010	5.494	0.445	1.066	1,412.20	10,900.00	310,952,000.00	25,349,648	3.96139	79.23333	0.542269	27.22812	1,653,384
2011	3.288	3.457	1.040	1,534.30	11,458.12	232,508,508.44	27,264,346	14.02249	88.81167	0.570862	30.57264	1,767,720
2012	1.816	2.738	1.215	1,689.90	12,097.59	223,173,173.63	30,734,367	9.37777	84.53000	0.577556	29.53616	1,914,823
2013	3.142	2.031	1.376	1,800.40	12,585.00	249,445,858.15	31,513,354	5.71749	86.12333	0.539545	31.71305	2,104,262
2014	2.695	1.336	1.602	2,195.30	13,000.00	231,683,195.10	33,812,990	6.87815	87.92250	0.556615	38.36356	2,309,874
2015	3.117	0.968	1.945	2,333.70	14,311.90	274,845,857.08	37,801,000	6.58217	98.17917	0.542271	40.20407	2,559,000
2016	3.346	0.981	2.061	2,327.00	15,500.00	274,672,326.73	39,054,774	6.29716	101.50417	0.497008	38.46368	2,720,600
2017	2.365	1.603	2.134	2,339.90	17,033.90	211,735,620.00	42,884,897	8.00572	103.41045	0.488617	34.43976	2,830,800
2018	3.895	1.852	2.489	2,711.70	18,655.01	172,456,761.99	49,524,567	4.68982	101.30157	0.473182	32.77122	2,942,700
2019	2.999	1.395	2.999	2,818.90	21,295.11	241,311,860.71	54,577,600	5.20000	101.99130	0.442802	27.54770	3,260,000

Appendix 2: Data Analysis EViews Raw Outputs

ANALYSIS OF RELATIONSHIP BETWEEN LNFDI, LNGDP and LNINFR

Appendix 2 (a): Lag Order Selection Criteria (LNFDI LNGDP LNINFR)

VAR Lag Order Selection Criteria
Endogenous variables: LNFDI LNGDP LNINFR
Exogenous variables: C LNOPN LNINFL LNEXC LNCRD LNLAB
Date: 05/08/21 Time: 10:07
Sample: 1970 2019
Included observations: 46

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-9.599558	NA	0.000669	1.199981	1.915536	1.468032
1	13.98838	37.94581*	0.000359	0.565723	1.639056*	0.967800*
2	25.12991	16.47009	0.000334	0.472613	1.903723	1.008715
3	35.23653	13.62196	0.000330*	0.424499*	2.213387	1.094627
4	43.00314	9.454999	0.000370	0.478124	2.624790	1.282278

** indicates lag order selected by the criterion*
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix 2 (b): ARDL Regression (Dependent Variable: LNFDI)

Dependent Variable: LNFDI
Method: ARDL
Date: 10/18/21 Time: 18:22
Sample (adjusted): 1973 2019
Included observations: 47 after adjustments
Maximum dependent lags: 3 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (3 lags, automatic): LNGDP LNINFR
Fixed regressors: LNOPN LNINFL LNEXC LNCRD LNLAB DUM C
Number of models evalulated: 48
Selected Model: ARDL(3, 0, 3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNFDI(-1)	-0.579512	0.177468	-3.265449	0.0026
LNFDI(-2)	-0.620573	0.177551	-3.495183	0.0014
LNFDI(-3)	-0.262945	0.173471	-1.515784	0.1394
LNGDP	-0.717498	0.736854	-0.973732	0.3375
LNINFR	-0.148969	2.256337	-0.066023	0.9478
LNINFR(-1)	3.737901	2.777731	1.345667	0.1879
LNINFR(-2)	3.091827	2.740160	1.128338	0.2676
LNINFR(-3)	3.717852	2.155665	1.724689	0.0942
LNOPN	4.553645	1.328964	3.426463	0.0017

LNINFL	-0.158061	0.291901	-0.541490	0.5919
LNEXC	-1.357449	0.481035	-2.821933	0.0081
LNCRD	0.323876	1.774767	0.182489	0.8563
LNLAB	-2.620241	1.460119	-1.794540	0.0822
DUM	-0.527423	0.837956	-0.629417	0.5335
C	36.56118	16.28727	2.244770	0.0318

R-squared	0.610152	Mean dependent var	-0.698542
Adjusted R-squared	0.439594	S.D. dependent var	1.204759
S.E. of regression	0.901886	Akaike info criterion	2.885229
Sum squared resid	26.02875	Schwarz criterion	3.475702
Log likelihood	-52.80289	Hannan-Quinn criter.	3.107428
F-statistic	3.577383	Durbin-Watson stat	2.150793
Prob(F-statistic)	0.001393		

Appendix 2 (c): ARDL Bounds Cointegration Test (Dependent Variable: LNFDI)

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNGDP	-0.291307	0.299288	-0.973334	0.3377
LNINFR	4.221877	0.825717	5.112981	0.0000

EC = LNFDI - (-0.2913*LNGDP + 4.2219*LNINFR)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	12.89992	10%	3.17	4.14
k	2	5%	3.79	4.85
		2.5%	4.41	5.52
		1%	5.15	6.36

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-6.163532	10%	-2.57	-3.21
		5%	-2.86	-3.53
		2.5%	-3.13	-3.8
		1%	-3.43	-4.1

Appendix 2 (d): Error Correction Regression (D(LNFDI), D(LNGDP, D(LNINFR))

ARDL Error Correction Regression
Dependent Variable: D(LNFDI)

Selected Model: ARDL(3, 0, 3)
Case 3: Unrestricted Constant and No Trend
Date: 10/18/21 Time: 18:54
Sample: 1970 2019
Included observations: 47

ECM Regression
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	36.56118	8.071177	4.529844	0.0001
D(LNFDI(-1))	0.883518	0.268331	3.292645	0.0024
D(LNFDI(-2))	0.262945	0.162437	1.618749	0.1153
D(LNINFR)	-0.148969	2.114507	-0.070451	0.9443
D(LNINFR(-1))	-6.809679	2.465470	-2.762021	0.0094
D(LNINFR(-2))	-3.717852	1.975281	-1.882189	0.0689
LNOPN	4.553645	1.204448	3.780691	0.0006
LNINFL	-0.158061	0.238865	-0.661719	0.5129
LNEXC	-1.357449	0.377024	-3.600429	0.0011
LNCRD	0.323876	1.679016	0.192896	0.8483
LNLAB	-2.620241	0.876709	-2.988723	0.0053
DUM	-0.527423	0.713646	-0.739054	0.4653
CointEq(-1)*	-2.463030	0.384106	-6.412371	0.0000

R-squared	0.771433	Mean dependent var	0.032770
Adjusted R-squared	0.690762	S.D. dependent var	1.573406
S.E. of regression	0.874958	Akaike info criterion	2.800123
Sum squared resid	26.02875	Schwarz criterion	3.311866
Log likelihood	-52.80289	Hannan-Quinn criter.	2.992695
F-statistic	9.562724	Durbin-Watson stat	2.150793
Prob(F-statistic)	0.000000		

Appendix 2 (e): ARDL Regression (Dependent Variable: LNGDP)
Dependent Variable: LNGDP
Method: ARDL
Date: 10/18/21 Time: 19:42
Sample (adjusted): 1974 2019
Included observations: 46 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): LNFDI LNINFR
Fixed regressors: LNOPN LNINFL LNEXC LNCRD LNLAB DUM C
Number of models evalulated: 100
Selected Model: ARDL(4, 0, 0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNGDP(-1)	0.153293	0.153279	1.000092	0.3245
LNGDP(-2)	-0.216145	0.161444	-1.338824	0.1898

LNGDP(-3)	-0.201258	0.118181	-1.702970	0.0980
LNGDP(-4)	-0.193838	0.073900	-2.622971	0.0131
LNFDI	-0.008785	0.027532	-0.319094	0.7517
LNINFR	0.056466	0.368743	0.153132	0.8792
LNOPN	0.380836	0.284230	1.339888	0.1894
LNINFL	-0.115409	0.050453	-2.287474	0.0287
LNEXC	-0.256912	0.111650	-2.301048	0.0278
LNCRD	-0.414094	0.314685	-1.315897	0.1973
LNLAB	0.337745	0.312809	1.079716	0.2881
DUM	0.200246	0.156428	1.280119	0.2094
C	1.428874	3.056748	0.467449	0.6433

R-squared	0.656986	Mean dependent var	2.259306
Adjusted R-squared	0.532253	S.D. dependent var	0.267156
S.E. of regression	0.182713	Akaike info criterion	-0.328712
Sum squared resid	1.101679	Schwarz criterion	0.188078
Log likelihood	20.56037	Hannan-Quinn criter.	-0.135119
F-statistic	5.267163	Durbin-Watson stat	2.086363
Prob(F-statistic)	0.000071		

Appendix 2 (f): ARDL Bounds Cointegration Test (LNGDP = LNFDI + LNINFR)

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNFDI	-0.006026	0.018904	-0.318759	0.7519
LNINFR	0.038730	0.255146	0.151796	0.8803

EC = LNGDP - (-0.0060*LNFDI + 0.0387*LNINFR)

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	13.34664	10%	3.17	4.14
k	2	5%	3.79	4.85
		2.5%	4.41	5.52
		1%	5.15	6.36

t-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-5.922322	10%	-2.57	-3.21
		5%	-2.86	-3.53
		2.5%	-3.13	-3.8
		1%	-3.43	-4.1

Appendix 2 (g): Error Correction Regression (D(LNGDP, D(LNFDI, D(LNINFR))

ARDL Error Correction Regression
Dependent Variable: D(LNGDP)
Selected Model: ARDL(4, 0, 0)
Case 3: Unrestricted Constant and No Trend
Date: 10/18/21 Time: 20:08
Sample: 1970 2019
Included observations: 46

ECM Regression
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.428874	1.405894	1.016345	0.3169
D(LNGDP(-1))	0.611241	0.166836	3.663720	0.0009
D(LNGDP(-2))	0.395096	0.126480	3.123782	0.0037
D(LNGDP(-3))	0.193838	0.071232	2.721221	0.0103
LNOPN	0.380836	0.207354	1.836649	0.0753
LNINFL	-0.115409	0.048906	-2.359819	0.0244
LNEXC	-0.256912	0.077390	-3.319702	0.0022
LNCRD	-0.414094	0.303389	-1.364892	0.1815
LNLAB	0.337745	0.156019	2.164764	0.0377
DUM	0.200246	0.143463	1.395800	0.1721
CointEq(-1)*	-1.457948	0.223727	-6.516640	0.0000

R-squared	0.649182	Mean dependent var	0.001749
Adjusted R-squared	0.548949	S.D. dependent var	0.264168
S.E. of regression	0.177416	Akaike info criterion	-0.415668
Sum squared resid	1.101679	Schwarz criterion	0.021615
Log likelihood	20.56037	Hannan-Quinn criter.	-0.251859
F-statistic	6.476696	Durbin-Watson stat	2.086363
Prob(F-statistic)	0.000015		

Appendix 2 (h): ARDL Regression (LNINFR = LNFDI + LNGDP)

Dependent Variable: LNINFR
Method: ARDL
Date: 10/18/21 Time: 20:24
Sample (adjusted): 1971 2019
Included observations: 49 after adjustments
Maximum dependent lags: 3 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (3 lags, automatic): LNFDI LNGDP
Fixed regressors: LNOPN LNINFL LNEXC LNCRD LNLAB DUM C
Number of models evalulated: 48
Selected Model: ARDL(1, 1, 1)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNINFR(-1)	0.614213	0.135341	4.538271	0.0001
LNFDI	0.003053	0.011340	0.269224	0.7893
LNFDI(-1)	0.019134	0.011272	1.697459	0.0980
LNGDP	-0.016860	0.047702	-0.353446	0.7258
LNGDP(-1)	-0.002911	0.024563	-0.118509	0.9063
LNOPN	0.183406	0.095620	1.918064	0.0628
LNINFL	-0.016347	0.021171	-0.772123	0.4449
LNEXC	-0.048738	0.032653	-1.492614	0.1440
LNCRD	-0.193829	0.124523	-1.556578	0.1281
LNLAB	0.264921	0.092274	2.871011	0.0067
DUM	-0.015121	0.061357	-0.246438	0.8067
C	-2.226721	1.032033	-2.157606	0.0375

R-squared	0.973317	Mean dependent var	0.728008
Adjusted R-squared	0.965384	S.D. dependent var	0.381054
S.E. of regression	0.070896	Akaike info criterion	-2.246309
Sum squared resid	0.185971	Schwarz criterion	-1.783007
Log likelihood	67.03458	Hannan-Quinn criter.	-2.070533
F-statistic	122.6964	Durbin-Watson stat	2.051124
Prob(F-statistic)	0.000000		

Appendix 2 (i): ARDL Bounds Cointegration Test LNINFR = (LNFDI + LNGDP)

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNFDI	0.057512	0.043863	1.311168	0.1979
LNGDP	-0.051248	0.140820	-0.363929	0.7180

EC = LNINFR - (0.0575*LNFDI -0.0512*LNGDP)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	2.797323	10%	3.17	4.14
k	2	5%	3.79	4.85
		2.5%	4.41	5.52
		1%	5.15	6.36

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-2.850483	10%	-2.57	-3.21
		5%	-2.86	-3.53

	2.5%	-3.13	-3.8
	1%	-3.43	-4.1

Appendix 2 (j): Short-run Regression (LNINFR = LNFDI + LNGDP)

Dependent Variable: D(LNINFR)
Method: Least Squares
Date: 10/18/21 Time: 21:17
Sample (adjusted): 1974 2019
Included observations: 46 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.049233	0.593782	0.082915	0.9345
D(LNFDI)	-0.001644	0.011392	-0.144331	0.8863
D(LNFDI(-1))	0.015058	0.014648	1.027970	0.3128
D(LNFDI(-2))	-0.002216	0.014529	-0.152485	0.8799
D(LNFDI(-3))	0.006183	0.011149	0.554605	0.5836
D(LNGDP)	0.012589	0.045593	0.276126	0.7845
D(LNGDP(-1))	-0.022271	0.045886	-0.485361	0.6312
D(LNGDP(-2))	0.105629	0.039000	-2.708468	0.0114
D(LNGDP(-3))	-0.022286	0.022433	-0.993438	0.3290
D(LNINFR(-1))	-0.239369	0.193691	-1.235831	0.2268
D(LNINFR(-2))	-0.304963	0.166052	-1.836552	0.0769
D(LNINFR(-3))	-0.080472	0.179671	-0.447887	0.6577
LNOPN	0.184747	0.110722	1.668571	0.1063
LNINFL	-0.018145	0.022333	-0.812492	0.4234
LNEXC	-0.031920	0.027613	-1.155972	0.2575
LNCRD	-0.167030	0.131194	-1.273150	0.2134
LNLAB	0.062056	0.063673	0.974592	0.3381
DUM	0.019227	0.060257	0.319089	0.7520

R-squared	0.533915	Mean dependent var	0.031372
Adjusted R-squared	0.250935	S.D. dependent var	0.079164
S.E. of regression	0.068516	Akaike info criterion	-2.237341
Sum squared resid	0.131443	Schwarz criterion	-1.521786
Log likelihood	69.45885	Hannan-Quinn criter.	-1.969290
F-statistic	1.886758	Durbin-Watson stat	2.481957
Prob(F-statistic)	0.066150		

Appendix 2 (k): Granger Causality Test (Endogenous variables: LNFDI, LNGDP, LNINFR)

Pairwise Granger Causality Tests
Date: 10/18/21 Time: 21:39
Sample: 1970 2019
Lags: 3

Null Hypothesis:	Obs	F-Statistic	Prob.
LNGDP does not Granger Cause LNFDI	47	0.65189	0.5864
LNFDI does not Granger Cause LNGDP		1.34987	0.2719

LNINFR does not Granger Cause LNFDI	47	2.37219	0.0847
LNFDI does not Granger Cause LNINFR		2.47121	0.0757
LNINFR does not Granger Cause LNGDP	47	1.70763	0.1808
LNGDP does not Granger Cause LNINFR		0.22848	0.8760

ANALYSIS OF RELATHIONSHIP BETWEEN LNFDI, LNGDP and LNENEI

Appendix 2 (l): Lag Order Selection Criteria (LNFDI, LNGDP and LNENEI)
VAR Lag Order Selection Criteria
Endogenous variables: LNFDI LNGDP LNENEI
Exogenous variables: C LNOPN LNINFL LNEXC LNCRD LNLAB
Date: 05/09/21 Time: 20:28
Sample: 1970 2019
Included observations: 46

Lag	LogL	LR	FPE	AIC	SC	HQ
0	0.510574	NA*	0.000431	0.760410	1.475965*	1.028461*
1	10.43543	15.96608	0.000419*	0.720199*	1.793532	1.122276
2	16.25023	8.595793	0.000492	0.858685	2.289796	1.394788
3	22.96102	9.044967	0.000564	0.958217	2.747105	1.628345
4	32.03502	11.04661	0.000595	0.954999	3.101665	1.759153

** indicates lag order selected by the criterion*
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix 2 (m): ARDL Model Regression (LNFDI = LNGDP + LNENEI)
Dependent Variable: LNFDI
Method: ARDL
Date: 10/19/21 Time: 12:52
Sample (adjusted): 1971 2019
Included observations: 49 after adjustments
Maximum dependent lags: 3 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (3 lags, automatic): LNGDP LNENEI
Fixed regressors: LNOPN LNINFL LNEXC LNCRD LNLAB DUM C
Number of models evaluated: 48
Selected Model: ARDL(1, 0, 0)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNFDI(-1)	-0.227592	0.159064	-1.430818	0.1604
LNGDP	-0.117000	0.710438	-0.164687	0.8700
LNENEI	-2.315073	2.118552	-1.092762	0.2812

LNOPN	3.563473	1.317547	2.704626	0.0101
LNINFL	0.172052	0.327876	0.524747	0.6027
LNEXC	-0.819165	0.559117	-1.465104	0.1509
LNCRD	-0.024254	1.943815	-0.012478	0.9901
LNLAB	3.769387	1.597181	2.360025	0.0234
DUM	-1.557703	0.887446	-1.755265	0.0871
C	-29.73541	11.78228	-2.523740	0.0158

R-squared	0.354184	Mean dependent var	-0.712568
Adjusted R-squared	0.205149	S.D. dependent var	1.181873
S.E. of regression	1.053692	Akaike info criterion	3.122382
Sum squared resid	43.30041	Schwarz criterion	3.508468
Log likelihood	-66.49836	Hannan-Quinn criter.	3.268862
F-statistic	2.376522	Durbin-Watson stat	2.185272
Prob(F-statistic)	0.029856		

Appendix 2 (n): ARDL Bounds Cointegration Test (LNFDI = LNGDP + LNENEI)

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNGDP	-0.095308	0.579851	-0.164367	0.8703
LNENEI	-1.885865	1.744204	-1.081218	0.2862

EC = LNFDI - (-0.0953*LNGDP -1.8859*LNENEI)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	20.54022	10%	3.17	4.14
k	2	5%	3.79	4.85
		2.5%	4.41	5.52
		1%	5.15	6.36

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-7.717582	10%	-2.57	-3.21
		5%	-2.86	-3.53
		2.5%	-3.13	-3.8
		1%	-3.43	-4.1

Appendix 2 (o): Error Correction Regression (LNFDI = LNGDP + LNENEI)

ARDL Error Correction Regression
Dependent Variable: D(LNFDI)

Selected Model: ARDL(1, 0, 0)
Case 3: Unrestricted Constant and No Trend
Date: 10/19/21 Time: 13:56
Sample: 1970 2019
Included observations: 49

ECM Regression
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-29.73541	7.730923	-3.846294	0.0004
LNOPN	3.563473	1.152141	3.092914	0.0037
LNINFL	0.172052	0.252451	0.681527	0.4996
LNEXC	-0.819165	0.363606	-2.252895	0.0300
LNCRD	-0.024254	1.733092	-0.013995	0.9889
LNLAB	3.769387	0.888652	4.241689	0.0001
DUM	-1.557703	0.816554	-1.907654	0.0638
CointEq(-1)*	-1.227592	0.152522	-8.048646	0.0000

R-squared	0.622034	Mean dependent var	0.009848
Adjusted R-squared	0.557504	S.D. dependent var	1.544896
S.E. of regression	1.027671	Akaike info criterion	3.040749
Sum squared resid	43.30041	Schwarz criterion	3.349618
Log likelihood	-66.49836	Hannan-Quinn criter.	3.157934
F-statistic	9.639354	Durbin-Watson stat	2.185272
Prob(F-statistic)	0.000001		

Appendix 2 (p): ARDL Model Regression (LNGDP = LNFDI + LNENEI)

Dependent Variable: LNGDP
Method: ARDL
Date: 10/19/21 Time: 14:16
Sample (adjusted): 1974 2019
Included observations: 46 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): LNFDI LNENEI
Fixed regressors: LNOPN LNINFL LNEXC LNCRD LNLAB DUM C
Number of models evalulated: 100
Selected Model: ARDL(4, 0, 0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNGDP(-1)	0.139759	0.149502	0.934833	0.3567
LNGDP(-2)	-0.235400	0.149972	-1.569629	0.1260
LNGDP(-3)	-0.192191	0.116678	-1.647191	0.1090
LNGDP(-4)	-0.193086	0.072998	-2.645076	0.0124
LNFDI	-0.004412	0.027409	-0.160958	0.8731
LNENEI	0.302848	0.400579	0.756024	0.4550
LNOPN	0.448255	0.243413	1.841542	0.0745

LNINFL	-0.124262	0.051449	-2.415258	0.0214
LNEXC	-0.321625	0.110567	-2.908869	0.0064
LNCRD	-0.511060	0.336728	-1.517722	0.1386
LNLAB	0.189268	0.301647	0.627448	0.5347
DUM	0.217210	0.152769	1.421822	0.1645
C	2.100516	2.067824	1.015810	0.3171

R-squared	0.662586	Mean dependent var	2.259306
Adjusted R-squared	0.539890	S.D. dependent var	0.267156
S.E. of regression	0.181216	Akaike info criterion	-0.345174
Sum squared resid	1.083692	Schwarz criterion	0.171616
Log likelihood	20.93899	Hannan-Quinn criter.	-0.151581
F-statistic	5.400232	Durbin-Watson stat	2.130170
Prob(F-statistic)	0.000056		

Appendix 2 (q): ARDL Bounds Cointegration Test (LNGDP = LNFDI + LNENEI)

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNFDI	-0.002979	0.018490	-0.161116	0.8730
LNENEI	0.204500	0.270445	0.756161	0.4549

EC = LNGDP - (-0.0030*LNFDI + 0.2045*LNENEI)

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	13.75075	10%	3.17	4.14
k	2	5%	3.79	4.85
		2.5%	4.41	5.52
		1%	5.15	6.36

t-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-6.411354	10%	-2.57	-3.21
		5%	-2.86	-3.53
		2.5%	-3.13	-3.8
		1%	-3.43	-4.1

Appendix 2 (r): Short-run Regression (LNGDP = LNFDI + LNENEI)

ARDL Error Correction Regression
Dependent Variable: D(LNGDP)
Selected Model: ARDL(4, 0, 0)

Case 3: Unrestricted Constant and No Trend
Date: 10/19/21 Time: 14:56
Sample: 1970 2019
Included observations: 46

ECM Regression
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.100516	1.383340	1.518438	0.1384
D(LNGDP(-1))	0.620677	0.165917	3.740899	0.0007
D(LNGDP(-2))	0.385277	0.124135	3.103689	0.0039
D(LNGDP(-3))	0.193086	0.070382	2.743405	0.0098
LNOPN	0.448255	0.207521	2.160047	0.0381
LNINFL	-0.124262	0.048235	-2.576189	0.0147
LNEXC	-0.321625	0.083091	-3.870761	0.0005
LNCRD	-0.511060	0.299634	-1.705615	0.0975
LNLAB	0.189268	0.147932	1.279422	0.2097
DUM	0.217210	0.142522	1.524040	0.1370
CointEq(-1)*	-1.480917	0.223888	-6.614558	0.0000

R-squared	0.654910	Mean dependent var	0.001749
Adjusted R-squared	0.556313	S.D. dependent var	0.264168
S.E. of regression	0.175962	Akaike info criterion	-0.432130
Sum squared resid	1.083692	Schwarz criterion	0.005154
Log likelihood	20.93899	Hannan-Quinn criter.	-0.268321
F-statistic	6.642289	Durbin-Watson stat	2.130170
Prob(F-statistic)	0.000011		

Appendix 2 (s): ARDL Model Regression (LNENEI = LNFDI + LNGDP)
Dependent Variable: LNENEI
Method: ARDL
Date: 10/19/21 Time: 15:13
Sample (adjusted): 1972 2019
Included observations: 48 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): LNGDP LNFDI
Fixed regressors: LNOPN LNINFL LNEXC LNCRD LNLAB DUM C
Number of models evaluated: 100
Selected Model: ARDL(2, 0, 0)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNENEI(-1)	0.348353	0.153234	2.273339	0.0289
LNENEI(-2)	0.192411	0.130797	1.471073	0.1497
LNGDP	0.011577	0.046945	0.246606	0.8066
LNFDI	-0.013288	0.009769	-1.360199	0.1820

LNOPN	0.062183	0.101514	0.612555	0.5439
LNINFL	0.035167	0.019623	1.792108	0.0813
LNEXC	0.027517	0.042929	0.640995	0.5255
LNCRD	0.211444	0.117700	1.796468	0.0806
LNLAB	0.361280	0.092273	3.915329	0.0004
DUM	-0.112882	0.055636	-2.028929	0.0497
C	-2.536961	0.656474	-3.864526	0.0004

R-squared	0.992211	Mean dependent var	6.728918
Adjusted R-squared	0.990106	S.D. dependent var	0.668094
S.E. of regression	0.066455	Akaike info criterion	-2.386534
Sum squared resid	0.163402	Schwarz criterion	-1.957717
Log likelihood	68.27682	Hannan-Quinn criter.	-2.224483
F-statistic	471.3262	Durbin-Watson stat	2.135121
Prob(F-statistic)	0.000000		

Appendix 2 (t): ARDL Bounds Cointegration Test (LNENEI = LNFDI + LNGDP)

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNGDP	0.025209	0.102216	0.246629	0.8066
LNFDI	-0.028935	0.023056	-1.254977	0.2174

EC = LNENEI - (0.0252*LNGDP -0.0289*LNFDI)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	4.863706	10%	3.17	4.14
k	2	5%	3.79	4.85
		2.5%	4.41	5.52
		1%	5.15	6.36

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-3.921712	10%	-2.57	-3.21
		5%	-2.86	-3.53
		2.5%	-3.13	-3.8
		1%	-3.43	-4.1

Appendix 2 (u): Short-run Regression (LNENEI = LNFDI + LNGDP)

ARDL Error Correction Regression

Dependent Variable: D(LNENEI)
Selected Model: ARDL(2, 0, 0)
Case 3: Unrestricted Constant and No Trend
Date: 10/19/21 Time: 15:35
Sample: 1970 2019
Included observations: 48

ECM Regression
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.536961	0.619084	-4.097929	0.0002
D(LNENEI(-1))	-0.192411	0.124531	-1.545092	0.1308
LNOPN	0.062183	0.082195	0.756530	0.4541
LNINFL	0.035167	0.016260	2.162788	0.0371
LNEXC	0.027517	0.035359	0.778236	0.4414
LNCRD	0.211444	0.111228	1.900996	0.0651
LNLAB	0.361280	0.089040	4.057485	0.0002
DUM	-0.112882	0.050971	-2.214645	0.0330
CointEq(-1)*	-0.459235	0.117101	-3.921712	0.0004

R-squared	0.491285	Mean dependent var	0.056618
Adjusted R-squared	0.386933	S.D. dependent var	0.082669
S.E. of regression	0.064729	Akaike info criterion	-2.469867
Sum squared resid	0.163402	Schwarz criterion	-2.119017
Log likelihood	68.27682	Hannan-Quinn criter.	-2.337281
F-statistic	4.707964	Durbin-Watson stat	2.135121
Prob(F-statistic)	0.000432		

Appendix 2 (v): Granger Causality Test (Endogenous variables: LNFDI, LNGDP, LNENEI)

Pairwise Granger Causality Tests
Date: 10/20/21 Time: 22:08
Sample: 1970 2019
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
LNGDP does not Granger Cause LNFDI	49	0.98265	0.3267
LNFDI does not Granger Cause LNGDP		1.89345	0.1755
LNENEI does not Granger Cause LNFDI	49	1.21709	0.2757
LNFDI does not Granger Cause LNENEI		5.34870	0.0253
LNENEI does not Granger Cause LNGDP	49	0.18843	0.6663
LNGDP does not Granger Cause LNENEI		0.00815	0.9284

ANALYSIS OF RELATIONSHIP BETWEEN LNFDI, LNGDP and LNTRAI

Appendix 2 (w): Lag Order Selection (LNFDI, LNGDP and LNTRAI)

VAR Lag Order Selection Criteria
Endogenous variables: LNFDI LNGDP LNTRAI
Exogenous variables: C LNOPN LNINFL LNEXC LNCRD LNLAB
Date: 05/09/21 Time: 20:31
Sample: 1970 2019
Included observations: 46

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-6.316220	NA	0.000580	1.057227	1.772782	1.325278
1	30.51405	59.24869*	0.000175*	-0.152785	0.920548*	0.249292*
2	38.66268	12.04580	0.000186	-0.115769	1.315342	0.420334
3	47.08771	11.35548	0.000197	-0.090770	1.698118	0.579358
4	57.88449	13.14391	0.000193	-0.168891*	1.977775	0.635263

** indicates lag order selected by the criterion*
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix 2 (x): ARDL Model Regression (LNFDI = LNGDP + LNTRAI)

Dependent Variable: LNFDI
Method: ARDL
Date: 10/19/21 Time: 19:43
Sample (adjusted): 1972 2019
Included observations: 48 after adjustments
Maximum dependent lags: 3 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (3 lags, automatic): LNGDP LNTRAI
Fixed regressors: LNOPN LNINFL LNEXC LNCRD LNLAB DUM C
Number of models evaluated: 48
Selected Model: ARDL(2, 0, 2)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNFDI(-1)	-0.412679	0.177855	-2.320309	0.0263
LNFDI(-2)	-0.307303	0.167956	-1.829666	0.0758
LNGDP	-0.105075	0.745369	-0.140971	0.8887
LNTRAI	-2.648793	3.603295	-0.735103	0.4672
LNTRAI(-1)	2.376074	4.860183	0.488886	0.6280
LNTRAI(-2)	6.694906	4.982037	1.343809	0.1877
LNOPN	7.369944	1.799267	4.096082	0.0002
LNINFL	0.003055	0.337120	0.009063	0.9928
LNEXC	-3.246796	0.898581	-3.613248	0.0009
LNCRD	1.159283	1.931047	0.600339	0.5521
LNLAB	0.221766	1.324583	0.167424	0.8680
DUM	-0.935557	0.873979	-1.070457	0.2917

C	-46.52295	13.85978	-3.356689	0.0019

R-squared	0.463436	Mean dependent var	-0.709141
Adjusted R-squared	0.279471	S.D. dependent var	1.194134
S.E. of regression	1.013628	Akaike info criterion	3.090763
Sum squared resid	35.96048	Schwarz criterion	3.597547
Log likelihood	-61.17832	Hannan-Quinn criter.	3.282277
F-statistic	2.519158	Durbin-Watson stat	2.372768
Prob(F-statistic)	0.016567		

Appendix 2 (y): ARDL Bounds Cointegration Test (LNFDI = LNGDP + LNTRAI)

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNGDP	-0.061091	0.432615	-0.141213	0.8885
LNTRAI	3.733869	1.491568	2.503318	0.0171

EC = LNFDI - (-0.0611*LNGDP + 3.7339*LNTRAI)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	14.17967	10%	3.17	4.14
k	2	5%	3.79	4.85
		2.5%	4.41	5.52
		1%	5.15	6.36

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-6.500648	10%	-2.57	-3.21
		5%	-2.86	-3.53
		2.5%	-3.13	-3.8
		1%	-3.43	-4.1

Appendix 2 (z): ARDL Error Correction Regression (LNFDI = LNGDP + LNTRAI)

ARDL Error Correction Regression
Dependent Variable: D(LNFDI)
Selected Model: ARDL(2, 0, 2)
Case 3: Unrestricted Constant and No Trend
Date: 10/19/21 Time: 20:33
Sample: 1970 2019
Included observations: 48

ECM Regression
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-46.52295	10.40917	-4.469421	0.0001
D(LNFDI(-1))	0.307303	0.159791	1.923149	0.0626
D(LNTRAI)	-2.648793	3.429078	-0.772451	0.4450
D(LNTRAI(-1))	-6.694906	4.094248	-1.635198	0.1110
LNOPN	7.369944	1.422980	5.179231	0.0000
LNINFL	0.003055	0.275210	0.011102	0.9912
LNEXC	-3.246796	0.674532	-4.813408	0.0000
LNCRD	1.159283	1.854041	0.625274	0.5358
LNLAB	0.221766	0.871747	0.254393	0.8007
DUM	-0.935557	0.787540	-1.187949	0.2429
CointEq(-1)*	-1.719982	0.256486	-6.705954	0.0000

R-squared	0.684576	Mean dependent var	0.025208
Adjusted R-squared	0.599327	S.D. dependent var	1.557459
S.E. of regression	0.985852	Akaike info criterion	3.007430
Sum squared resid	35.96048	Schwarz criterion	3.436247
Log likelihood	-61.17832	Hannan-Quinn criter.	3.169480
F-statistic	8.030253	Durbin-Watson stat	2.372768
Prob(F-statistic)	0.000001		

Appendix 2 (aa): ARDL Model Regression (LNGDP = LNFDI + LNTRAI)
Dependent Variable: LNGDP
Method: ARDL
Date: 10/19/21 Time: 16:04
Sample (adjusted): 1973 2019
Included observations: 47 after adjustments
Maximum dependent lags: 3 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (3 lags, automatic): LNFDI LNTRAI
Fixed regressors: LNOPN LNINFL LNEXC LNCRD LNLAB DUM C
Number of models evalulated: 48
Selected Model: ARDL(2, 2, 3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNGDP(-1)	0.188370	0.154403	1.219988	0.2317
LNGDP(-2)	-0.165418	0.128964	-1.282672	0.2091
LNFDI	-5.79E-05	0.032859	-0.001763	0.9986
LNFDI(-1)	-0.013675	0.037728	-0.362456	0.7195
LNFDI(-2)	-0.058079	0.035084	-1.655412	0.1079
LNTRAI	1.359508	0.762944	1.781923	0.0846
LNTRAI(-1)	-1.511975	0.999288	-1.513052	0.1404
LNTRAI(-2)	-0.896888	1.088497	-0.823970	0.4163
LNTRAI(-3)	1.770727	0.833434	2.124616	0.0417
LNOPN	0.637351	0.450959	1.413325	0.1675

LNINFL	-0.144297	0.059894	-2.409194	0.0221
LNEXC	-0.384255	0.235545	-1.631348	0.1129
LNCRD	-0.053069	0.396483	-0.133849	0.8944
LNLAB	-0.060849	0.272255	-0.223499	0.8246
DUM	0.249343	0.173019	1.441136	0.1596
C	-1.098188	3.430280	-0.320145	0.7510

R-squared	0.635182	Mean dependent var	2.262307
Adjusted R-squared	0.458657	S.D. dependent var	0.265036
S.E. of regression	0.195003	Akaike info criterion	-0.166914
Sum squared resid	1.178810	Schwarz criterion	0.462923
Log likelihood	19.92248	Hannan-Quinn criter.	0.070098
F-statistic	3.598252	Durbin-Watson stat	2.220771
Prob(F-statistic)	0.001257		

Appendix 2 (bb): ARDL Bounds Cointegration Test (LNGDP = LNFDI + LNTRAI)

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNFDI	-0.073498	0.078104	-0.941039	0.3540
LNTRAI	0.738316	0.668638	1.104208	0.2780

EC = LNGDP - (-0.0735*LNFDI + 0.7383*LNTRAI)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	14.25233	10%	3.17	4.14
k	2	5%	3.79	4.85
		2.5%	4.41	5.52
		1%	5.15	6.36

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-6.510749	10%	-2.57	-3.21
		5%	-2.86	-3.53
		2.5%	-3.13	-3.8
		1%	-3.43	-4.1

Appendix 2 (cc): ARDL Short-run Model (LNGDP = LNFDI +LNTRAI)

ARDL Error Correction Regression
Dependent Variable: D(LNGDP)
Selected Model: ARDL(2, 2, 3)

Case 3: Unrestricted Constant and No Trend
Date: 10/19/21 Time: 16:39
Sample: 1970 2019
Included observations: 47

ECM Regression
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.098188	1.654186	-0.663884	0.5117
D(LNGDP(-1))	0.165418	0.124182	1.332061	0.1926
D(LNFDI)	-5.79E-05	0.021869	-0.002649	0.9979
D(LNFDI(-1))	0.058079	0.024307	2.389433	0.0231
D(LNTRAI)	1.359508	0.734912	1.849891	0.0739
D(LNTRAI(-1))	-0.873838	0.754114	-1.158762	0.2554
D(LNTRAI(-2))	-1.770727	0.704310	-2.514129	0.0173
LNOPN	0.637351	0.246224	2.588504	0.0145
LNINFL	-0.144297	0.057103	-2.526955	0.0168
LNEXC	-0.384255	0.103654	-3.707087	0.0008
LNCRD	-0.053069	0.350559	-0.151383	0.8807
LNLAB	-0.060849	0.180766	-0.336616	0.7387
DUM	0.249343	0.160168	1.556756	0.1297
CointEq(-1)*	-0.977049	0.144823	-6.746518	0.0000

R-squared	0.672645	Mean dependent var	-0.012848
Adjusted R-squared	0.543687	S.D. dependent var	0.279791
S.E. of regression	0.189001	Akaike info criterion	-0.252021
Sum squared resid	1.178810	Schwarz criterion	0.299087
Log likelihood	19.92248	Hannan-Quinn criter.	-0.044635
F-statistic	5.215992	Durbin-Watson stat	2.220771
Prob(F-statistic)	0.000060		

Appendix 2 (dd): ARDL Model Regression (LNTRAI = LNFDI + LNGDP)
Dependent Variable: LNTRAI
Method: ARDL
Date: 10/19/21 Time: 21:27
Sample (adjusted): 1973 2019
Included observations: 47 after adjustments
Maximum dependent lags: 3 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (3 lags, automatic): LNFDI LNGDP
Fixed regressors: LNOPN LNINFL LNEXC LNCRD LNLAB DUM C
Number of models evalulated: 48
Selected Model: ARDL(3, 0, 0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNTRAI(-1)	0.892936	0.164517	5.427623	0.0000
LNTRAI(-2)	0.435748	0.206627	2.108866	0.0422

LNTRAI(-3)	-0.428173	0.173202	-2.472098	0.0184
LNFDI	-0.007527	0.006611	-1.138462	0.2627
LNGDP	0.061912	0.035002	1.768815	0.0856
LNOPN	0.015230	0.076142	0.200026	0.8426
LNINFL	0.001010	0.013235	0.076305	0.9396
LNEXC	-0.023092	0.037826	-0.610483	0.5455
LNCRD	0.011670	0.075863	0.153827	0.8786
LNLAB	0.096839	0.056573	1.711742	0.0958
DUM	-0.037052	0.037549	-0.986780	0.3305
C	-0.471257	0.549742	-0.857233	0.3971

R-squared	0.990870	Mean dependent var	9.017855
Adjusted R-squared	0.988000	S.D. dependent var	0.397375
S.E. of regression	0.043530	Akaike info criterion	-3.214899
Sum squared resid	0.066320	Schwarz criterion	-2.742521
Log likelihood	87.55013	Hannan-Quinn criter.	-3.037140
F-statistic	345.3085	Durbin-Watson stat	2.067185
Prob(F-statistic)	0.000000		

Appendix 2 (ee): ARDL Bounds Cointegration Test (LNTRAI = LNFDI + LNGDP)

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNFDI	-0.075656	0.120901	-0.625769	0.5355
LNGDP	0.622304	0.811550	0.766809	0.4483

EC = LNTRAI - (-0.0757*LNFDI + 0.6223*LNGDP)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	1.585284	10%	3.17	4.14
k	2	5%	3.79	4.85
		2.5%	4.41	5.52
		1%	5.15	6.36

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-0.805690	10%	-2.57	-3.21
		5%	-2.86	-3.53
		2.5%	-3.13	-3.8
		1%	-3.43	-4.1

Appendix 2 (ff): Short-run Regression (LNTRAI = LNFDI + LNGDP)

Dependent Variable: D(LNTRAI)
Method: Least Squares
Date: 10/19/21 Time: 21:57
Sample (adjusted): 1972 2019
Included observations: 48 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.746221	0.382833	-1.949207	0.0591
D(LNFDI)	-0.003666	0.005292	-0.692719	0.4929
D(LNFDI(-1))	-0.001791	0.005690	-0.314764	0.7548
D(LNGDP)	-0.013193	0.027663	-0.476915	0.6363
D(LNGDP(-1))	0.001661	0.014281	0.116283	0.9081
D(LNTRAI(-1))	-0.191984	0.186836	-1.027555	0.3110
LNOPN	0.073157	0.056561	1.293417	0.2041
LNINFL	-0.007976	0.014506	-0.549824	0.5858
LNEXC	-0.069925	0.019493	-3.587148	0.0010
LNCRD	-0.017853	0.086004	-0.207583	0.8367
LNLAB	0.087549	0.041053	2.132572	0.0399
DUM	-0.011790	0.038792	-0.303921	0.7629

R-squared	0.360672	Mean dependent var	0.040130
Adjusted R-squared	0.165321	S.D. dependent var	0.051955
S.E. of regression	0.047467	Akaike info criterion	-3.045260
Sum squared resid	0.081111	Schwarz criterion	-2.577460
Log likelihood	85.08624	Hannan-Quinn criter.	-2.868477
F-statistic	1.846281	Durbin-Watson stat	2.118073
Prob(F-statistic)	0.081853		

Appendix 2 (gg): Granger Causality Test (Endogenous variables: LNFDI LNGDP LNTRAI)

Pairwise Granger Causality Tests
Date: 10/23/21 Time: 14:30
Sample: 1970 2019
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
LNGDP does not Granger Cause LNFDI	49	0.98265	0.3267
LNFDI does not Granger Cause LNGDP		1.89345	0.1755
LNTRAI does not Granger Cause LNFDI	49	1.03767	0.3137
LNFDI does not Granger Cause LNTRAI		4.54792	0.0383
LNTRAI does not Granger Cause LNGDP	49	0.67823	0.4144
LNGDP does not Granger Cause LNTRAI		3.07278	0.0863

ANALYSIS OF RELATIONSHIP BETWEEN LNFDI, LNGDP and LNWATI

Appendix 2 (hh): Lag Order Selection (LNFDI, LNGDP and LNWATI)
VAR Lag Order Selection Criteria
Endogenous variables: LNFDI LNGDP LNWATI
Exogenous variables: C LNOPN LNINFL LNEXC LNCRD LNLAB
Date: 05/09/21 Time: 20:33
Sample: 1970 2019
Included observations: 46

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-81.58175	NA	0.015306	4.329641	5.045197*	4.597693
1	-67.82667	22.12774	0.012583	4.122899	5.196232	4.524976
2	-52.57979	22.53887*	0.009801*	3.851295*	5.282406	4.387398*
3	-47.00747	7.510519	0.011806	4.000325	5.789213	4.670453
4	-38.28435	10.61944	0.012663	4.012363	6.159029	4.816517

** indicates lag order selected by the criterion*
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix 2 (ii): ARDL short-run model (LNFDI = LNGDP + LNWATI)
Dependent Variable: LNFDI
Method: ARDL
Date: 10/19/21 Time: 21:20
Sample (adjusted): 1973 2019
Included observations: 47 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): LNGDP LNWATI
Fixed regressors: LNOPN LNINFL LNEXC LNCRD LNLAB DUM C
Number of models evalulated: 100
Selected Model: ARDL(2, 0, 3)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNFDI(-1)	-0.385436	0.158711	-2.428541	0.0208
LNFDI(-2)	-0.523128	0.196476	-2.662547	0.0119
LNGDP	-0.695739	0.805691	-0.863531	0.3941
LNWATI	0.067238	0.436871	0.153909	0.8786
LNWATI(-1)	0.937128	0.475714	1.969940	0.0573
LNWATI(-2)	-0.073521	0.411327	-0.178741	0.8592
LNWATI(-3)	0.658207	0.390034	1.687566	0.1009
LNOPN	3.455305	1.285083	2.688781	0.0112
LNINFL	-0.221756	0.316044	-0.701663	0.4878
LNEXC	-0.630842	0.544264	-1.159074	0.2547
LNCRD	0.573607	1.782280	0.321839	0.7496
LNLAB	0.858500	0.967692	0.887162	0.3814

DUM	-0.792393	0.860180	-0.921194	0.3636
C	-36.77434	9.991364	-3.680612	0.0008

R-squared	0.536955	Mean dependent var	-0.698542
Adjusted R-squared	0.354543	S.D. dependent var	1.204759
S.E. of regression	0.967908	Akaike info criterion	3.014744
Sum squared resid	30.91588	Schwarz criterion	3.565852
Log likelihood	-56.84649	Hannan-Quinn criter.	3.222130
F-statistic	2.943645	Durbin-Watson stat	2.227828
Prob(F-statistic)	0.006063		

Appendix 2 (jj): ARDL Bounds Cointegration Test (LNFDI = LNGDP + LNWATI)

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNGDP	-0.364535	0.411634	-0.885581	0.3823
LNWATI	0.832591	0.248678	3.348066	0.0020

EC = LNFDI - (-0.3645*LNGDP + 0.8326*LNWATI)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	17.28363	10%	3.17	4.14
k	2	5%	3.79	4.85
		2.5%	4.41	5.52
		1%	5.15	6.36

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-7.109321	10%	-2.57	-3.21
		5%	-2.86	-3.53
		2.5%	-3.13	-3.8
		1%	-3.43	-4.1

Appendix 2 (kk): ARDL Error Correction Regression (LNFDI = LNGDP + LNWATI)

ARDL Error Correction Regression
Dependent Variable: D(LNFDI)
Selected Model: ARDL(2, 0, 3)
Case 3: Unrestricted Constant and No Trend
Date: 10/20/21 Time: 12:50
Sample: 1970 2019
Included observations: 47

ECM Regression
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-36.77434	9.045645	-4.065419	0.0003
D(LNFDI(-1))	0.523128	0.181811	2.877317	0.0070
D(LNWATI)	0.067238	0.364753	0.184339	0.8549
D(LNWATI(-1))	-0.584686	0.362617	-1.612409	0.1164
D(LNWATI(-2))	-0.658207	0.346050	-1.902060	0.0659
LNOPN	3.455305	1.108398	3.117386	0.0038
LNINFL	-0.221756	0.256548	-0.864386	0.3936
LNEXC	-0.630842	0.331728	-1.901686	0.0660
LNCRD	0.573607	1.722811	0.332948	0.7413
LNLAB	0.858500	0.782053	1.097751	0.2803
DUM	-0.792393	0.790628	-1.002232	0.3235
CointEq(-1)*	-1.908564	0.257366	-7.415751	0.0000

R-squared	0.728517	Mean dependent var	0.032770
Adjusted R-squared	0.643194	S.D. dependent var	1.573406
S.E. of regression	0.939846	Akaike info criterion	2.929638
Sum squared resid	30.91588	Schwarz criterion	3.402016
Log likelihood	-56.84649	Hannan-Quinn criter.	3.107397
F-statistic	8.538327	Durbin-Watson stat	2.227828
Prob(F-statistic)	0.000000		

Appendix 2 (ll): ARDL Model Regression (LNGDP = LNFDI + LNWATI)
Dependent Variable: LNGDP
Method: ARDL
Date: 10/20/21 Time: 13:02
Sample (adjusted): 1974 2019
Included observations: 46 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): LNFDI LNWATI
Fixed regressors: LNOPN LNINFL LNEXC LNCRD LNLAB DUM C
Number of models evalulated: 100
Selected Model: ARDL(4, 0, 0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNGDP(-1)	0.091578	0.152308	0.601267	0.5518
LNGDP(-2)	-0.284945	0.153186	-1.860124	0.0718
LNGDP(-3)	-0.235349	0.117332	-2.005837	0.0531
LNGDP(-4)	-0.196240	0.071639	-2.739293	0.0099
LNFDI	-0.003055	0.026741	-0.114245	0.9097
LNWATI	-0.105442	0.078042	-1.351100	0.1859
LNOPN	0.613778	0.279064	2.199413	0.0350
LNINFL	-0.108617	0.049288	-2.203729	0.0346

LNEXC	-0.381490	0.118263	-3.225781	0.0028
LNCRD	-0.434602	0.306670	-1.417166	0.1658
LNLAB	0.500463	0.189651	2.638858	0.0126
DUM	0.207331	0.147246	1.408061	0.1685
C	2.318202	1.755020	1.320898	0.1956

R-squared	0.674735	Mean dependent var	2.259306
Adjusted R-squared	0.556457	S.D. dependent var	0.267156
S.E. of regression	0.177923	Akaike info criterion	-0.381843
Sum squared resid	1.044673	Schwarz criterion	0.134947
Log likelihood	21.78239	Hannan-Quinn criter.	-0.188250
F-statistic	5.704643	Durbin-Watson stat	2.219191
Prob(F-statistic)	0.000033		

Appendix 2 (mm): ARDL Bounds Cointegration Test (LNGDP = LNFDI + LNWATI)

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNFDI	-0.001880	0.016461	-0.114213	0.9098
LNWATI	-0.064889	0.044388	-1.461872	0.1532

EC = LNGDP - (-0.0019*LNFDI -0.0649*LNWATI)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	14.67519	10%	3.17	4.14
k	2	5%	3.79	4.85
		2.5%	4.41	5.52
		1%	5.15	6.36

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-6.406317	10%	-2.57	-3.21
		5%	-2.86	-3.53
		2.5%	-3.13	-3.8
		1%	-3.43	-4.1

Appendix 2 (nn): ARDL Short-run Model Regression (LNGDP = LNFDI + LNWATI)

ARDL Error Correction Regression
Dependent Variable: D(LNGDP)
Selected Model: ARDL(4, 0, 0)
Case 3: Unrestricted Constant and No Trend

Date: 10/20/21 Time: 13:30
Sample: 1970 2019
Included observations: 46

ECM Regression
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.318202	1.356273	1.709245	0.0968
D(LNGDP(-1))	0.716535	0.172439	4.155299	0.0002
D(LNGDP(-2))	0.431590	0.125591	3.436458	0.0016
D(LNGDP(-3))	0.196240	0.069001	2.844026	0.0076
LNOPN	0.613778	0.209995	2.922825	0.0062
LNINFL	-0.108617	0.047793	-2.272645	0.0297
LNEXC	-0.381490	0.087343	-4.367713	0.0001
LNCRD	-0.434602	0.295055	-1.472951	0.1502
LNLAB	0.500463	0.161596	3.097003	0.0040
DUM	0.207331	0.139772	1.483349	0.1475
CointEq(-1)*	-1.624957	0.237800	-6.833285	0.0000

R-squared	0.667335	Mean dependent var	0.001749
Adjusted R-squared	0.572288	S.D. dependent var	0.264168
S.E. of regression	0.172765	Akaike info criterion	-0.468800
Sum squared resid	1.044673	Schwarz criterion	-0.031516
Log likelihood	21.78239	Hannan-Quinn criter.	-0.304990
F-statistic	7.021104	Durbin-Watson stat	2.219191
Prob(F-statistic)	0.000006		

Appendix 2 (oo): ARDL Model Regression (LNWATI = LNFDI + LNGDP)
Dependent Variable: LNWATI
Method: ARDL
Date: 10/20/21 Time: 13:50
Sample (adjusted): 1972 2019
Included observations: 48 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): LNFDI LNGDP
Fixed regressors: LNOPN LNINFL LNEXC LNCRD LNLAB DUM C
Number of models evaluated: 100
Selected Model: ARDL(1, 2, 2)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNWATI(-1)	0.473225	0.148222	3.192670	0.0030
LNFDI	0.012680	0.059656	0.212548	0.8329
LNFDI(-1)	0.080325	0.058706	1.368257	0.1802
LNFDI(-2)	-0.169126	0.068634	-2.464166	0.0189
LNGDP	-0.446372	0.297679	-1.499509	0.1430

LNGDP(-1)	-0.335276	0.227359	-1.474653	0.1495
LNGDP(-2)	-0.272500	0.135390	-2.012709	0.0521
LNOPN	1.273078	0.494974	2.572010	0.0147
LNINFL	-0.175059	0.110041	-1.590855	0.1209
LNEXC	-0.664654	0.192872	-3.446082	0.0015
LNCRD	-0.066681	0.651368	-0.102371	0.9191
LNLAB	0.597459	0.318012	1.878732	0.0689
DUM	0.252213	0.300780	0.838528	0.4076
C	8.115750	3.930968	2.064568	0.0467

R-squared	0.770233	Mean dependent var	18.67917
Adjusted R-squared	0.682380	S.D. dependent var	0.617508
S.E. of regression	0.348014	Akaike info criterion	0.965343
Sum squared resid	4.117861	Schwarz criterion	1.511110
Log likelihood	-9.168236	Hannan-Quinn criter.	1.171589
F-statistic	8.767368	Durbin-Watson stat	2.221671
Prob(F-statistic)	0.000000		

Appendix 2 (pp): ARDL Bounds Cointegration Test (LNWATI = LNFDI + LNGDP)

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNFDI	-0.144504	0.294822	-0.490140	0.6272
LNGDP	-2.001136	0.878233	-2.278594	0.0291

EC = LNWATI - (-0.1445*LNFDI -2.0011*LNGDP)

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	9.018606	10%	3.17	4.14
k	2	5%	3.79	4.85
		2.5%	4.41	5.52
		1%	5.15	6.36

t-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-3.553950	10%	-2.57	-3.21
		5%	-2.86	-3.53
		2.5%	-3.13	-3.8
		1%	-3.43	-4.1

Appendix 2 (qq): ARDL Error Correction Regression (LNWATI = LNFDI + LNGDP)

ARDL Error Correction Regression
Dependent Variable: D(LNWATI)
Selected Model: ARDL(1, 2, 2)
Case 3: Unrestricted Constant and No Trend
Date: 10/20/21 Time: 14:08
Sample: 1970 2019
Included observations: 48

ECM Regression
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.115750	2.641130	3.072833	0.0042
D(LNFDI)	0.012680	0.037468	0.338416	0.7371
D(LNFDI(-1))	0.169126	0.040107	4.216843	0.0002
D(LNGDP)	-0.446372	0.207581	-2.150354	0.3870
D(LNGDP(-1))	0.272500	0.110681	2.462023	0.0190
LNOPN	1.273078	0.430775	2.955316	0.0056
LNINFL	-0.175059	0.097579	-1.794021	0.0817
LNEXC	-0.664654	0.174067	-3.818384	0.0005
LNCRD	-0.066681	0.619725	-0.107598	0.9149
LNLAB	0.597459	0.296874	2.012503	0.0521
DUM	0.252213	0.272805	0.924516	0.3617
CointEq(-1)*	-0.526775	0.098420	-5.352321	0.0000

R-squared	0.586858	Mean dependent var	0.025553
Adjusted R-squared	0.460620	S.D. dependent var	0.460508
S.E. of regression	0.338209	Akaike info criterion	0.882010
Sum squared resid	4.117861	Schwarz criterion	1.349810
Log likelihood	-9.168236	Hannan-Quinn criter.	1.058792
F-statistic	4.648826	Durbin-Watson stat	2.221671
Prob(F-statistic)	0.000213		

Appendix 2 (rr): Granger Causality Test (Endogenous variables: LNFDI LNGDP LNWATI)

Pairwise Granger Causality Tests
Date: 10/20/21 Time: 22:31
Sample: 1970 2019
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
LNGDP does not Granger Cause LNFDI	48	1.19887	0.3114
LNFDI does not Granger Cause LNGDP		0.64063	0.5319
LNWATI does not Granger Cause LNFDI	48	7.70273	0.0014
LNFDI does not Granger Cause LNWATI		5.13990	0.0100
LNWATI does not Granger Cause LNGDP	48	2.09725	0.1352

LNGDP does not Granger Cause LNWATI	0.17059	0.8437

ANALYSING THE RELATIONSHIP BETWEEN LNFDI, LNGDP and LNICTI

Appendix 2 (ss): Lag Order Selection (LNFDI, LNGDP and LNICTI)
VAR Lag Order Selection Criteria
Endogenous variables: LNFDI LNGDP LNICTI
Exogenous variables: C LNOPN LNINFL LNEXC LNCRD LNLAB
Date: 05/09/21 Time: 20:36
Sample: 1970 2019
Included observations: 46

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-81.00817	NA	0.014929	4.304703	5.020258	4.572754
1	-18.08342	101.2268	0.001447	1.960149	3.033482	2.362226
2	1.260843	28.59587*	0.000943	1.510398	2.941509*	2.046501*
3	12.41764	15.03742	0.000891*	1.416624*	3.205513	2.086753
4	21.03119	10.48607	0.000961	1.433426	3.580092	2.237580

** indicates lag order selected by the criterion*
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix 2 (tt): ARDL Model Regression (LNFDI = LNGDP + LNICTI)
Dependent Variable: LNFDI
Method: ARDL
Date: 10/20/21 Time: 14:18
Sample (adjusted): 1972 2019
Included observations: 48 after adjustments
Maximum dependent lags: 3 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (3 lags, automatic): LNGDP LNICTI
Fixed regressors: LNOPN LNINFL LNEXC LNCRD LNLAB DUM C
Number of models evaluated: 48
Selected Model: ARDL(2, 0, 1)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNFDI(-1)	-0.298572	0.145122	-2.057386	0.0469
LNFDI(-2)	-0.324430	0.154413	-2.101048	0.1427
LNGDP	-0.677730	0.683844	-0.991060	0.3283
LNICTI	-3.813055	1.101046	-3.463119	0.0014
LNICTI(-1)	3.416614	1.133219	3.014962	0.4700
LNOPN	4.941075	1.492774	3.309996	0.0021
LNINFL	-0.425527	0.318464	-1.336187	0.1899

LNEXC	-1.041898	0.427119	-2.439365	0.0198
LNCRD	-0.421304	1.723163	-0.244495	0.8082
LNLAB	2.395686	1.372631	1.745324	0.0895
DUM	0.249088	1.161092	0.214529	0.8313
C	-15.83321	10.24747	-1.545085	0.1311

R-squared	0.530537	Mean dependent var	-0.709141
Adjusted R-squared	0.387090	S.D. dependent var	1.194134
S.E. of regression	0.934870	Akaike info criterion	2.915500
Sum squared resid	31.46338	Schwarz criterion	3.383301
Log likelihood	-57.97201	Hannan-Quinn criter.	3.092283
F-statistic	3.698489	Durbin-Watson stat	2.385689
Prob(F-statistic)	0.001411		

Appendix 2 (uu): ARDL Bounds Cointegration Test (LNFDI = LNGDP + LNICTI)

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNGDP	-0.417578	0.416236	-1.003225	0.3224
LNICTI	-0.244264	0.308037	-0.792969	0.4330

EC = LNFDI - (-0.4176*LNGDP -0.2443*LNICTI)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	17.00669	10%	3.17	4.14
k	2	5%	3.79	4.85
		2.5%	4.41	5.52
		1%	5.15	6.36

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-7.100889	10%	-2.57	-3.21
		5%	-2.86	-3.53
		2.5%	-3.13	-3.8
		1%	-3.43	-4.1

Appendix 2 (vv): ARDL Error Correction Regression (LNFDI = LNGDP + LNICTI)

ARDL Error Correction Regression
Dependent Variable: D(LNFDI)
Selected Model: ARDL(2, 0, 1)
Case 3: Unrestricted Constant and No Trend

Date: 10/20/21 Time: 14:36
Sample: 1970 2019
Included observations: 48

ECM Regression
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-15.83321	7.570889	-2.091328	0.0436
D(LNFDI(-1))	0.324430	0.148875	2.179212	0.0359
D(LNICTI)	-3.813055	1.049815	-3.632120	0.0009
LNOPN	4.941075	1.122439	4.402087	0.0001
LNINFL	-0.425527	0.244969	-1.737064	0.0909
LNEXC	-1.041898	0.409655	-2.543356	0.0154
LNCRD	-0.421304	1.624868	-0.259285	0.7969
LNLAB	2.395686	0.796042	3.009498	0.0048
DUM	0.249088	0.754508	0.330133	0.7432
CointEq(-1)*	-1.623002	0.221161	-7.338564	0.0000

R-squared	0.724022	Mean dependent var	0.025208
Adjusted R-squared	0.658659	S.D. dependent var	1.557459
S.E. of regression	0.909936	Akaike info criterion	2.832167
Sum squared resid	31.46338	Schwarz criterion	3.222001
Log likelihood	-57.97201	Hannan-Quinn criter.	2.979486
F-statistic	11.07691	Durbin-Watson stat	2.385689
Prob(F-statistic)	0.000000		

Appendix 2 (ww): ARDL Model Regression (LNGDP = LNFDI + LNICTI)
Dependent Variable: LNGDP
Method: ARDL
Date: 10/20/21 Time: 20:21
Sample (adjusted): 1973 2019
Included observations: 47 after adjustments
Maximum dependent lags: 3 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (3 lags, automatic): LNFDI LNICTI
Fixed regressors: LNOPN LNINFL LNEXC LNCRD LNLAB DUM C
@TREND
Number of models evalulated: 48
Selected Model: ARDL(3, 2, 3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNGDP(-1)	0.087710	0.190516	0.460380	0.6487
LNGDP(-2)	-0.346614	0.146276	-2.369584	0.0247
LNGDP(-3)	-0.188696	0.083862	-2.250077	0.0322
LNFDI	-0.040636	0.032598	-1.246563	0.2225
LNFDI(-1)	-0.064783	0.035733	-1.812950	0.0802
LNFDI(-2)	-0.046295	0.034994	-1.322959	0.1962

LNICTI	0.029064	0.344813	0.084288	0.9334
LNICTI(-1)	-1.214965	0.598040	-2.031579	0.0514
LNICTI(-2)	1.382684	0.609825	2.267346	0.0310
LNICTI(-3)	-0.430076	0.314531	-1.367358	0.1820
LNOPN	1.043324	0.356795	2.924154	0.0066
LNINFL	-0.133043	0.062888	-2.115543	0.0431
LNEXC	-1.132809	0.478083	-2.369482	0.0247
LNCRD	-0.422953	0.346461	-1.220783	0.2320
LNLAB	-0.149900	0.532196	-0.281664	0.7802
DUM	0.111650	0.260478	0.428636	0.6714
C	11.72535	7.450186	1.573833	0.1264
@TREND	0.125353	0.068277	1.835947	0.0766

R-squared	0.712302	Mean dependent var	2.262307
Adjusted R-squared	0.543652	S.D. dependent var	0.265036
S.E. of regression	0.179041	Akaike info criterion	-0.319297
Sum squared resid	0.929616	Schwarz criterion	0.389271
Log likelihood	25.50347	Hannan-Quinn criter.	-0.052658
F-statistic	4.223540	Durbin-Watson stat	2.355920
Prob(F-statistic)	0.000330		

Appendix 2 (xx): ARDL Bounds Cointegration Test (LNGDP = LNFDI + LNICTI)

Levels Equation
Case 5: Unrestricted Constant and Unrestricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNFDI	-0.104804	0.048726	-2.150890	0.1400
LNICTI	-0.161159	0.099172	-1.625054	0.1150

EC = LNGDP - (-0.1048*LNFDI -0.1612*LNICTI)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	9.307375	10%	4.19	5.06
k	2	5%	4.87	5.85
		2.5%	5.79	6.59
		1%	6.34	7.52

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-5.257620	10%	-3.13	-3.63
		5%	-3.41	-3.95
		2.5%	-3.65	-4.2

		1%	-3.96	-4.53

Appendix 2 (yy): ARDL Short-run Model Regression (LNGDP = LNFDI + LNICTI)
ARDL Error Correction Regression
Dependent Variable: D(LNGDP)
Selected Model: ARDL(3, 2, 3)
Case 5: Unrestricted Constant and Unrestricted Trend
Date: 10/20/21 Time: 20:47
Sample: 1970 2019
Included observations: 47

ECM Regression
Case 5: Unrestricted Constant and Unrestricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.72535	7.162784	1.636982	0.1124
@TREND	0.125353	0.062500	2.005648	0.0543
D(LNGDP(-1))	0.535310	0.166565	3.213828	0.0032
D(LNGDP(-2))	0.188696	0.080144	2.354468	0.0255
D(LNFDI)	-0.040636	0.022119	-1.837161	0.0765
D(LNFDI(-1))	0.046295	0.025242	1.834083	0.0769
D(LNICTI)	0.029064	0.293503	0.099024	0.9218
D(LNICTI(-1))	-0.952607	0.344220	-2.767435	0.0097
D(LNICTI(-2))	0.430076	0.302209	1.423108	0.1654
LNOPN	1.043324	0.254694	4.096380	0.0003
LNINFL	-0.133043	0.059727	-2.227533	0.0338
LNEXC	-1.132809	0.440134	-2.573784	0.0154
LNCRD	-0.422953	0.329412	-1.283963	0.2093
LNLAB	-0.149900	0.498458	-0.300728	0.7658
DUM	0.111650	0.197418	0.565553	0.5760
CointEq(-1)*	-1.447600	0.264967	-5.463313	0.0000

R-squared	0.741846	Mean dependent var	-0.012848
Adjusted R-squared	0.616932	S.D. dependent var	0.279791
S.E. of regression	0.173169	Akaike info criterion	-0.404403
Sum squared resid	0.929616	Schwarz criterion	0.225434
Log likelihood	25.50347	Hannan-Quinn criter.	-0.167391
F-statistic	5.938882	Durbin-Watson stat	2.355920
Prob(F-statistic)	0.000015		

Appendix 2 (zz): ARDL Model Regression (LNICTI = LNFDI + LNGDP)
Dependent Variable: LNICTI
Method: ARDL
Date: 10/20/21 Time: 21:11
Sample (adjusted): 1972 2019
Included observations: 48 after adjustments
Maximum dependent lags: 3 (Automatic selection)
Model selection method: Akaike info criterion (AIC)

Dynamic regressors (3 lags, automatic): LNGDP LNFDI
Fixed regressors: LNOPN LNINFL LNEXC LNCRD LNLAB DUM C
@TREND
Number of models evaluated: 48
Selected Model: ARDL(2, 1, 0)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNICTI(-1)	1.388703	0.118015	11.76715	0.0000
LNICTI(-2)	-0.580529	0.115935	-5.007390	0.0000
LNGDP	0.035258	0.072871	0.483844	0.6315
LNGDP(-1)	-0.136549	0.064086	-2.130729	0.0402
LNFDI	-0.028817	0.014243	-2.023217	0.0507
LNOPN	0.274521	0.143994	1.906471	0.0648
LNINFL	-0.022442	0.029944	-0.749468	0.4586
LNEXC	-0.294001	0.146921	-2.001079	0.0532
LNCRD	-0.001873	0.170205	-0.011003	0.9913
LNLAB	-0.181415	0.213946	-0.847947	0.4022
DUM	0.244639	0.110300	2.217950	0.0331
C	5.188059	2.684068	1.932909	0.0614
@TREND	0.053791	0.022996	2.339123	0.0252

R-squared	0.998991	Mean dependent var	13.57823
Adjusted R-squared	0.998644	S.D. dependent var	2.500733
S.E. of regression	0.092073	Akaike info criterion	-1.706648
Sum squared resid	0.296713	Schwarz criterion	-1.199865
Log likelihood	53.95956	Hannan-Quinn criter.	-1.515134
F-statistic	2886.320	Durbin-Watson stat	1.847196
Prob(F-statistic)	0.000000		

Appendix 2 (aaa): ARDL Bounds Cointegration Test (LNICTI = LNFDI + LNGDP)

Levels Equation
Case 5: Unrestricted Constant and Unrestricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNGDP	-0.528037	0.412864	-1.278962	0.2093
LNFDI	-0.150227	0.093944	-1.599112	0.1188

EC = LNICTI - (-0.5280*LNGDP -0.1502*LNFDI)

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	6.457054	10%	4.19	5.06
k	2	5%	4.87	5.85

		2.5%	5.79	6.59
		1%	6.34	7.52

t-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-4.525272	10%	-3.13	-3.63
		5%	-3.41	-3.95
		2.5%	-3.65	-4.2
		1%	-3.96	-4.53

Appendix 2 (bbb): ARDL Short-run Regression (LNICTI = LNFDI + LNGDP)

ARDL Error Correction Regression
Dependent Variable: D(LNICTI)
Selected Model: ARDL(2, 1, 0)
Case 5: Unrestricted Constant and Unrestricted Trend
Date: 10/20/21 Time: 21:44
Sample: 1970 2019
Included observations: 48

ECM Regression
Case 5: Unrestricted Constant and Unrestricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.188059	2.364046	2.194568	0.0349
@TREND	0.053791	0.020421	2.634109	0.0125
D(LNICTI(-1))	0.580529	0.105682	5.493186	0.0000
D(LNGDP)	0.035258	0.057944	0.608491	0.5468
LNOPN	0.274521	0.139706	1.964995	0.0574
LNINFL	-0.022442	0.027489	-0.816419	0.4198
LNEXC	-0.294001	0.132411	-2.220368	0.0330
LNCRD	-0.001873	0.165517	-0.011315	0.9910
LNLAB	-0.181415	0.197260	-0.919675	0.3640
DUM	0.244639	0.100635	2.430948	0.0203
CointEq(-1)*	-0.191826	0.042390	-4.525272	0.0001

R-squared	0.744030	Mean dependent var	0.150642
Adjusted R-squared	0.674849	S.D. dependent var	0.157045
S.E. of regression	0.089550	Akaike info criterion	-1.789982
Sum squared resid	0.296713	Schwarz criterion	-1.361165
Log likelihood	53.95956	Hannan-Quinn criter.	-1.627931
F-statistic	10.75483	Durbin-Watson stat	1.847196
Prob(F-statistic)	0.000000		

Appendix 2 (ccc): Granger Causality Test (Endogenous variables: LNFDI, LNGDP, LNICTI)

Pairwise Granger Causality Tests

Date: 10/20/21 Time: 22:39
Sample: 1970 2019
Lags: 3

Null Hypothesis:	Obs	F-Statistic	Prob.
LNGDP does not Granger Cause LNFDI	47	0.65189	0.5864
LNFDI does not Granger Cause LNGDP		1.34987	0.2719
LNICTI does not Granger Cause LNFDI	47	2.65491	0.0615
LNFDI does not Granger Cause LNICTI		1.47187	0.2367
LNICTI does not Granger Cause LNGDP	47	3.24822	0.0317
LNGDP does not Granger Cause LNICTI		1.01754	0.3950

Appendix 3: Language Editing Certificate

EDITING AND PROOFREADING CERTIFICATE

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0008

13 December 2021

TO WHOM IT MAY CONCERN

This certificate serves to confirm that I have language edited ZK Irungu's thesis entitled, **"Effect of Infrastructure on FDI Behaviour in Kenya: A Growth Nexus Analysis."**

I found the work easy and intriguing to read. Much of my editing basically dealt with obstructionist technical aspects of language, which could have otherwise compromised smooth reading as well as the sense of the information being conveyed. I hope that the work will be found to be of an acceptable standard. I am a member of Professional Editors' Guild.

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