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FACULTY OF COMMERCE, LAW & MANAGEMENT

The Role of Financial development on infrastructure development and financing in Africa: a cross-country study

Masters in Finance and Investment

Research Report

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Abstract

This study examines the nexus between financial development and infrastructure development and financing. To this end, we employ three panel estimation techniques – Fixed effects, Orthogonal deviation and First difference – to examine to investigate the relationship between financial development and infrastructure development for a panel of 28 African countries. In addition, MIDAS regression was employed to uncover the relationship between bond market development and infrastructure financing for selected African countries. Results indicate the financial development has a positive and statistically significant relationship on infrastructure development. This is however weak and suggest that more needs to be done to improve financial markets further in order for them to have a greater impact on infrastructure development. Surprisingly, we do not find any statistically significant relationship between financial development and infrastructure finance.

Declaration

I, Simo S. Vuza hereby declare that this research report submitted for the degree of Master of Management in Finance and Investment (MMFI), at the University of the Witwatersrand Business School is my own unaided work, except where otherwise indicated and acknowledged. This thesis has not, either in part or whole been previously submitted to any other institution of higher learning for any degree or diploma.

…….. ……..

Simo S. Vuza Date

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CHAPTER 1: INTRODUCTION

1.1. Background of the study

The key role of infrastructure development in driving sustainable economic growth and poverty reduction across the African continent cannot be overemphasized. In fact, the World Bank's 1994 World Development Report stresses the fact that countries with adequate and efficient supply of infrastructure services tend to have higher levels of productivity growth (World Bank 1994). Calderon (2009) further points out that the volume of infrastructure stocks and the quality of infrastructure services have a positive effect on economic growth in Africa. On the other hand, deficient infrastructure hinders productivity and brings about an increase in transaction and production cost, which makes businesses less competitive and affects the ability of governments to pursue policies that bring about economic and social development, ultimately hindering growth (Calderon, 2009; AfDB, 2011).

Indeed, the role of infrastructure in accelerating Africa's growth and development is encapsulated in Aspiration 2 of African Union's (2014) Agenda 2063, which states as follows:

> *By 2063, the necessary infrastructure will be in place to support Africa's accelerated integration and growth, technological transformation, trade and development. This will include high-speed railway networks, roads, shipping lines, sea and air transport, as well as well-developed ICT and digital economy. A Pan African High Speed Rail network will connect all the major cities/capitals of the continent, with adjacent highways and pipelines for gas, oil, water, as well as ICT Broadband cables and other infrastructure. This will be a catalyst for manufacturing, skills development, technology, research and development, integration and intra-African trade, investments and tourism.*

Nevertheless, infrastructure development in Africa largely remains at sub-optimal levels compared to other regions of the world (AfDB, 2011). Indeed, Africa, particularly those south of the Sahara, is regarded as the region with the most

deficient and costly infrastructure in the developing world (AfDB, 2011). This tag comes as no surprise, considering the region's colossal infrastructure funding gap per year. Specifically, in the entire Africa, the investment needs for infrastructure development was estimated at $93 billion at the end of the last decade (Foster and Briceño-Garmendia 2009). At that time, infrastructure spending for the entire Africa region stood at only about $45 billion a year (AfDB, 2013a; ACBF, 2016), thus leaving a huge gap which needs to be closed. This vast infrastructure deficit is a constraint on Africa's growth – it depletes growth by as much as 2% per year (Calderon, 2009).

There is need for adequate infrastructure – efficient transport, proper and affordable housing, reliable energy, proper communication systems, and resilient sanitation – to reverse the lost growth opportunities plaguing the continent. According to African Development Bank (AfDB), about 600 million people are without electricity in Africa, as the household electrification rate in Africa stands at just 43%. About 53% of roads in Africa are unpaved, keeping people apart from economic opportunities, basic education, health services, and trade hubs, among other opportunities. The rail sector is not spared, as its effectiveness has been undermined by outdated infrastructure and inadequate maintenance. Furthermore, many ports in Africa are ill equipped and operated uneconomically with handling costs averaging 50% more in Africa than in other parts of the world. Current investments in sanitation are less than 0.1% of GDP in most countries. Consequently, poor sanitation and inadequate water costs Africa an average of 5% of its GDP. In dollar terms, Nigeria, Kenya and Ghana lose $3 billion, $324 million, and $290 million, respectively, due to poor sanitation (AfDB, n.d).

Given these observations, it is apparent that closing the infrastructure financing gap is vital for Sub-Saharan Africa's transformation. Raising the huge sum estimated at about $93 billion per year (AfDB, 2011) brings up the issue of which financing mechanisms are available. Infrastructure projects can be financed through a number of mechanisms including government funding, corporate or on-balance sheet finance, and project finance (World Bank, 2016). The Government may decide to fund part or the entire capital investment in a project. On the other hand, the private sector may choose to finance part of the capital investment for an infrastructure

project via corporate financing, where financing for the project is based on the balance sheet of the private sector rather than the project itself. Alternatively, project financing, also known as limited recourse or non-recourse financing, could be used.[1] As echoed by Ehlers (2014), infrastructure finance can be bolstered by tapping the vast resources of capital markets, through the creation of a variety of financial instruments that attract broader group of investors. This speaks to having a well-developed financial sector in place.

According to Schumpeter (1912), savings and investment allocation (which includes infrastructure investment) are influenced by the level of financial sector development. In other words, a well-developed financial sector makes it easier to reallocate resources from low to high productive sectors, which plays a vital role in total factor productivity and investment (Huang, 2010). Hence, a well-developed financial sector is necessary for mobilizing savings, allocating credit, and most importantly, investment.

Given the seeming importance of financial development in economic growth Schumpeter (1912), it is surprising that little is known about the role it plays in promoting infrastructure development and infrastructure financing in the sub region. Specifically, it remains unclear whether greater level of financial development is associated with more infrastructure development. In particular, very little is known about the role financial development plays in infrastructure financing in Sub-Saharan Africa. Hence, a vital task is to examine the nexus between financial development and infrastructure development, on one hand, and financial development and infrastructure financing on the other. Save for a few studies that did examine the causal relationship between infrastructure and financial development in Asian countries (see e.g Pradhan, Arvin and Norman, 2016; Pradhan, Arvin and Hall, 2016), the extant literature has not adequately explored these relationships in Sub-Saharan Africa. This study intends to analyse the role of financial development on infrastructure development and financing in Africa in an effort to fill the lacunae in the literature.

[1] "This takes the form of limited recourse lending to a specially created project vehicle (special purpose vehicle or "SPV") which has the right to carry out the construction and operation of the project" (World Bank, 2016)

Sub-Saharan Africa witnessed strong growth between the periods 2006 to 2014. Around the same period, there was an improvement in the business environment coupled with strong commodity demand. These factors drew the attention of investors to the continent and, together with record low interest rates in developed markets, led to increasing capital flows to the region over the last decade. It is estimated that private flows grew astronomically from US$13.2 billion in 2003 to USD$ 48.3 billion in 2012 (Masetti and Mihr, 2013).

Meanwhile, Sub-Saharan Africa's capital markets remain in their infancy, lacking liquidity and depth with the more active and liquid stocks markets (South Africa, Nigeria, Kenya, Mauritius and Zimbabwe) continuing to attract a large portion of portfolio equity investment in SSA. (Yartey and Adjasi, 2007; Sebnet, 2008; Andrianaivo and Yartey, 2010;). The Johannesburg Stock Exchange (JSE) remains the most advanced and biggest in the sub-region, representing 83% of total market capitalisation as of 2012, while Nigeria follows with 7.7% (Masetti and Mihr, 2013). Stock market capitalisation in the region remains very low only at around 10% of GDP, if South Africa and Nigeria are excluded (Masetti and Mihr, 2013). The average turnover ratio (liquidity measure) for emerging countries was at 120.7 in 2010, compared to 6, 11.1, 14.8 and 4.5 for West Africa Southern Africa, North Africa and East Africa, respectively. This is an indication of the relatively efficiency of the African markets (Kodongo and Ojah, 2015). African markets also fall short in terms of the extent of equity capital supply (measured by listed IPOs). The average number of listed firms for emerging markets was at 2504 in 2010, compared to 81.7, 101.3, 321.3, and 21.7 for West Africa Southern Africa, North Africa and East Africa, respectively (Kodongo and Ojah, 2015).

Indeed, African countries stand to benefit from greater access to financing and deeper financial markets if the bond markets are properly developed. Furthermore, promoting bond market development would reduce the prominence of banks and improve the structure of the African financial system. Obtaining bank funding for development projects has become increasingly difficult for African governments, in the aftermath of the Global Financial Crisis; due to this, bonds have become more attractive as an alternative source of funding for developmental projects (KPMG, 2015). Consequently, the African bond market has seen a steady growth in recent

years – the amount of local currency debt securities issued increased from US$11 billion in 2005 to US$31 billion in 2012 (Masetti and Mihr, 2013).

Yet, bond markets in Africa remain at a nascent stage of development, despite the recent steady growth. Reasons for this state of affairs include the absence of a secondary markets and some instances primary markets where bonds can be traded; lack of institutional investors due to regulatory restrictions on investments by pension funds and insurers; lack of institutional infrastructure in the form of rating agencies and clearing and settlement systems; ill protection of debt securities holders due to lack of appropriate regulation; and lack of familiarity by various African governments with the process of structuring and issuing bonds (KPMG, 2015). Moreover, there is a predominance of government debt securities over corporate bonds, which remain non-existent in most African countries. Government debt securities account for over 75% of total debt market capitalisation in the region (Masetti and Mihr, 2013). Maturities vary across countries and range up to 26 years in South Africa. However, there are higher rollover risks due to frequent debt refinancing, as most of the bonds are short-term.

Various efforts have been made in recent years to further promote and strengthen bond market development and ultimately increase their capacity to fund infrastructure projects. For instance, the African Development Bank recently announced its intention to launch a new bond programme for infrastructure, aiming to raise up to US$40 billion for various infrastructure projects (Mu, Phelps, and Stotsky, 2013).

1.2. Statement of the Problem

Infrastructure development in Sub-Saharan African economies have been at sub-optimal levels over the last decades. Indeed, current infrastructure spending for the entire Africa is only about $45 billion a year (AfDB, 2013a; ACBF, 2016), which is far below the $93 billion investment needs (Foster and Briceño-Garmendia 2009), thus leaving a colossal gap. It is therefore not surprising that the sub region occupies an unenviable position as the region with the most deficient and costly infrastructure in the developing world (AfDB, 2011). As a consequence of the deficiencies in

infrastructure development and financing, growth opportunities have been thwarted in most economies in the sub region (ACBF, 2016). Sub-Saharan Africa capital markets remain in their infancy, lacking liquidity and depth, although efforts have been made to bolster their development. Government bonds dominate domestic debt markets, accounting for over 75% of total debt market capitalisation, while corporate bonds remain non-existent in most African countries (Masetti and Mihr, 2013). While anecdotally, the level of infrastructure development and financing has been linked to financial development, we are unaware of studies that examine the relationship between financial development and infrastructure development or the relationship between financial development, specifically bond market development, and infrastructure financing. It is therefore interesting to empirically understand the role of financial development on infrastructure development and financing in Africa. This study examines these issues with the view of informing infrastructure development and financing policy.

1.3. Objectives of the study

The proposed study's objectives are as follows:

i. Examine the relationship between financial development and infrastructure development in Sub-Saharan Africa.
ii. Examine the relationship between specific aspects of financial development, particularly bond market development, and infrastructure financing in Sub-Saharan Africa.

1.4. Research questions

The study mainly seeks to explore the role of financial development in enhancing infrastructure development and financing. Consistent with the research objectives, this research seeks to answer the following questions

i. Does the level of financial development in a country affect infrastructure development?
ii. What is the nature of the relationship between specific aspect(s) of financial development, particularly bond market development, and infrastructure financing in Sub-Saharan Africa?

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

The literature review documents the theoretical and empirical base for understanding how capital structure and corporate citizenship, a constituent of corporate governance, impact firm performance. The first section gives an overview infrastructure financing in Africa. The various financing initiatives launched to bridge the infrastructure gap in Sub-Saharan Africa as well as the various sources of financing are discussed. Thereafter, the prominence of banks in financing infrastructure and the recent initiatives from the African Development Bank to develop local currency infrastructure bond markets are discussed. The second section explores the relationship between financial development and infrastructure development and financing.

2.2. Infrastructure Financing in Africa

Achieving sustainable growth and distributing its benefits for poverty alleviation on the continent has been greatly hindered by the lack of infrastructure (NEPAD, 2014). In response to this challenge, numerous financing initiatives have been launched to bridge the infrastructure gap in the sub-region. For instance, the World Bank's World Development Report (WDR, 1994), *Infrastructure for Development,* outlined new ways of financing and operating infrastructure and related services. Some of the notable global and regional initiatives undertaken to bridge the infrastructure gap include the New Partnership for Africa's Development (NEPAD), which was established in 2001 under the African Union; the Africa Infrastructure Country Diagnostics (AICD), established by the World Bank in collaboration with the African Development Bank (AfDB); the Infrastructure Consortium for Africa (ICA), established in 2005 by the G-8 Summit at Gleaneagles; The Africa50 Infrastructure Fund, launched in 2013 by the AfDB to aid in mobilizing resources and support key development projects; and the Global Infrastructure Fund (GIF), launched in 2014 by the World Bank to help finance large infrastructure projects (Gutma, Sy and Chattopadhyay, 2015).

According to the ICA report 2015, financing of Africa's infrastructure is from eight main sources, namely: multilateral development banks, regional development banks, Europe (European Commission, France, Germany, UK), the Americas (US, Canada, Brazil), Arab Co-ordination Group, Asia (China, Japan, India, South Korea), African national governments and the private sector. Recently, there has been upsurge in traditional bilateral and multilateral development flows to African infrastructure; funding from Europe increased from $5.4 billion in 2014 to $5.6 billion in 2015 (ICA, 2015). In addition, there is a growing trend of non-traditional bilateral flows, mainly from China, Brazil, and India. China funding, for instance, was nearly $21 billion in 2015 compared with $3 billion in the previous year (ICA, 2015).

There have also been calls for private finance to augment the investment from national governments and international development bodies, such as the World Bank. Accordingly, private sector participation in infrastructure has been increasing gradually in recent times, although private finance had previously dwindled due to the financial crisis of the 1990s (Gutma, Sy and Chattopadhyay, 2015). The Infrastructure Consortium 2014 report (ICA, 2014) indicates that the total infrastructure funding for Africa in 2015 was $74.5 billion of which the private sector financed $2.9 billion (3.9%) while African national governments financed $34.5 billion (45.9%). However, the figures for the private sector saw an improvement in the subsequent year, where the total was $83.5 billion of which the private sector and African national governments financed $7.4 billion (8.9%) and $28.4 billion, respectively (ICA, 2015). The sub region is now the fourth largest recipient of private participation in infrastructure (PPI). Sub-Saharan African accounts for about 10% of global PPI (private participation in infrastructure, making it the fourth largest recipient globally (Gutma, Sy and Chattopadhyay, 2015).

In terms of the types of funding, loans and grants are the major financial instruments used in infrastructure funding commitments, accounting for 73% and 12% of funding in 2015. Other funding types are gradually gaining grounds, although on a lower scale (ICA, 2015). Some of these include, blended funding, which combines different categories of funding, guarantees and insurance, and equity investment.

African financial markets have been characterized by the prominence of banks, which are adept at providing short-term capital. It is no doubt that African

infrastructure development and financing stand to benefit from greater access to financing and deeper financial markets. In particular, deep and liquid bond markets are necessary to sustain development over a considerable number of years, as they tend to be more adept at financing infrastructure investment, government deficits and providing longer-term capital to companies for growth (Mu, Phelps, and Stotsky, 2013). Yet, there are very limited and underdeveloped bond markets, with corporate bond markets non-existent or in their infancy (AfDB, 2008), thus pushing the bulk of credit onto banks and other credit intermediaries. Consequently, the vast majority of funding for capital spending and infrastructure projects has been heavily dependent on external grants and concessional loans.

In 2008, the African Development Bank (AfDB) Group launched the African Financial Markets Initiative (AIFI), with the intention of further developing local currency bond markets on the continent (AfDB, 2008). Moreover, the AfDB, in 2012, made known its plan to launch a new bond programme for infrastructure, targeting to raise up to US$40 billion for investment in various infrastructure projects, such as port and airports (Mu, Phelps, and Stotsky, 2013). Kenya is among the few African countries that have been able to issue infrastructure bonds to the tune of $1 billion (in local currency) on the domestic market. The vast majority of African countries still rely on traditional forms, such as loans and grants, while a few others, such as Ghana and Ethiopia, have made use of Eurobonds in recent times.

The scanty empirical literature also proposes various funding instruments that could be employed in Africa. For instance, Atta-Mensah (2010) proposes two ways for financing infrastructure in Africa. The first involves using bonds indexed to projects that will ensure diversification of financial risk. The second approach involves the creation of an African Investment Guarantee Agency (AIGA) that will support the financing of projects in the form of offering non-commercial investment guarantees to those who desire to invest in Africa (African and non-African) but have an aversion for non-commercial risks. Employing option-pricing techniques, the author finds, among other things, that the bond indexed investment is akin to a regular bond and a short positon on a European put option. These developments highlight the need for well-developed financial sectors in financing development in sub-Saharan Africa.

2.3. Financial Development and Infrastructure

Financial development, in the view of Sahay, Čihák, N'Diaye and Barajas (2015), encompasses a combination of financial sector depth, access, and efficiency. In other words, a country considered financially developed should have an element of depth (i.e. market should be sizeable and liquid enough), and be efficient in terms of the ability of institutions to provide financial services at low cost. Moreover, there should be access for a large number of people and very limited exclusion.

Financial development (FD) relates to "the factors, policies, and institutions that lead to effective financial intermediation and markets, as well as deep and broad access to capital and financial services"(WEF, 2012: p.3). This encompasses the institutional and business environments that form the support base of a financial system; the financial entities (intermediaries and markets) that aid in effective management of risk and efficient capital allocation; and the outcomes of financial intermediation process, which include ease of accessing capital (WEF, 2012).

Deeper financial development – improved efficiency, accessibility of the financial sector and increase in deposits and loans – enhances economic growth. It is not surprising that financial development has gained prominence in global economic discourse in recent times. This is for a number of reasons. First, deeper financial development facilitates the easy mobilization of savings and channels funds into productive uses, such as by providing venture capital to start-up companies with great growth potential. The result of this is a more efficient allocation of resources and increase in overall productivity. Secondly, a well-developed financial sector aids in better monitoring and management of risks, makes payments easier and facilitates the development of new products and services (IMF, 2016). Thirdly, it helps in the creation of instruments, such as bonds indexed to infrastructure projects, insurance for large infrastructure projects that reduce risk over delays and helps firms cope with requirements for projects with non-recourse financing.

Literature on financial development has been growing rapidly in recent decades with ample evidence mainly on the effects of financial development on economic growth. Early works that considered the finance-growth nexus include Schumpeter (1912), Robinson (1952) and Lewis (1955) who documented the existence of a relationship

between financial development and economic growth. Robinson (1952) championed the demand-following hypothesis, which suggests that demand for financial services due to economic growth supports financial development. That is, financial development responds passively to economic growth due to greater demand for financial services (Ang, 2008). Logically, this implies that economic growth leads to demand for financial products and financial markets develop further as they respond to this demand (Bara, Mugano and Roux, 2016). Lewis (1995) on his part argued that financial market development is usually in response to economic growth, and there is a feedback effect from financial markets that propels economic growth, hence a bi-directional relationship.

Many studies have emerged following these theoretical paths. Recent studies that provide empirical support to the positive effect of financial development on economic growth include King and Levine (1993); Beck et al. (2000), Adjasi and Biekpe (2006), Manu et al. (2011), Kendall (2010) and Bara, Mugano and Roux (2016). A sub-strand focuses on the capital flows and financial development, with the consensus that strong financial markets are necessary for capital flows to impact economic growth positively. For instance, Alfaro et al. (2004) provide evidence that countries with strong financial markets benefit more from foreign direct investment inflows. Further, Choong et al. (2010) document that robust financial markets play a crucial role in the linkage between capital flows and economic growth. Recently, employing a panel Instrumental Generalized Method of Moments (IV-GMM) estimator, Agbloyor et al (2014), examine the relation between private capital flows and economic growth in Africa during the 1990 -2007 and found that countries with strong domestic financial markets are able to positively transform the impact of capital flows on economic growth.

In contrast, another strand of the literature argues that financial development is not growth enhancing. An example is Lucas (1988) who points out that financial development cannot be a pre-condition for economic growth. Similarly, McKinnon (1973) and Shaw (1973) dismissed the role of financial intermediaries in the development process. Research findings of Henderson, Papageorgiou and Parmeter (2013) revealed that although the positive impact of financial development on growth has increased over time, low income economies do not benefit (in terms of growth)

from financial development. Lartey and Farka (2011) also document that countries with less-developed financial systems tend to be less affected by crises than those with well-developed financial systems.

The extent of financial system development, no doubt has an effect on investment in infrastructure and infrastructure development at large. Yet, there is limited empirical evidence on this linkage. For instance, Ray (2015) found that investment in infrastructure, for the purpose of boosting trade and connecting the South Asian and Southeast Asian regions, has been stifled by the lack of participation by commercial banks in project finance. This resulted in increased participation by multilateral financial institutions and export credit agencies. This problem was attributed to the lack of market depth and limited capabilities of the local region's credit and equity capital markets for financing infrastructure projects; the Asian financial system is dominated by banks who focus more on loans, with underdeveloped bond markets.

As pointed out Ehlers (2014), infrastructure finance can be boosted by tapping the vast resources of capital markets, through the creation of a variety of financial instruments that attract broader group of investors. Regan, Smith and Love (2011), conclude that capital markets have an impact on the funding arrangements for economic and social infrastructure projects in Australia. By extension, this could mean that a well-developed financial system is generally essential for exploring alternative infrastructure financing instruments.

Coinciding with the widening infrastructure finance gap in Africa are domestic capital markets that are deemed not so conducive to infrastructure finance. With the exception of a few countries, such as South Africa, African capital markets remain dominated by commercial banks with a short-term focus. Yet, so far, the above review does not point to a clear linkage between financial development and infrastructure development, on one hand, and between financial development and infrastructure finance, on the other hand. One could make intuitive deductions on these relationships, given that financial development affects investment, of which infrastructure investment could be a part. Yet, drawing on such deductions, without any empirical support could be misleading. An empirical investigation to establish the true nature of these relationships in Africa is therefore in order.

CHAPTER 3: EMPIRICAL FRAMEWORK AND DATA

3.1. Financial development and infrastructure development

The specification that would capture the linkage between financial development and infrastructure development is as follows

$$InfDev_{it} = \beta_0 + \beta_1 InfDev_{it-1} + \beta_2 FinDev_{it} + \sum_{j=1}^{N} \delta_j X_{it} + \varepsilon_{it} \quad (1)$$

Where

(i = 1,….., N) is a country index and the n in this study is the number of countries, which is all countries in sub-Saharan Africa.

(t = 1,……T) is time observations from 1=2000, T=2015.

$InfDev_{it}$ is the growth rate of infrastructure development variables (the proxy variable is discussed in section 3.5.2), $FinDev_{it}$ represents the growth rate (log difference) financial development, ε_{it} is the random error term. X_{it} is a vector of control variables that affect infrastructure development, such as the growth rate of GDP per capita, political and economic risk, macroeconomic stability, legal and regulatory frameworks, credibility of government policies, and transparency. The choice and justification for each of these variables are captured under section 3.5.4.

A priori, growth in financial development is expected to have a positive impact on infrastructure developments. Should this be the case, then β_2 would be positive. The lag of infrastructure development growth is included in the specification because current infrastructure stock depends on previous infrastructure stock and this variable indirectly corrects for any possible autocorrelation.

This study tries to explore how various aspects of financial development affect infrastructure development, as encapsulated in the second research question. In this

regard, various measures of $FinDev_{it}$ (equity market and debt market specific variables) are employed in order to establish which one of the two are more useful for infrastructure development. These variables are discussed in section 3.5.

3.2. Financial development and infrastructure finance

The nexus between financial development and infrastructure finance are empirically tested using the following specification

$$InfFin_t = \beta_0 + \beta_1 InfFin_{t-1} + \beta_2 FinDev_t + \sum_{j=1}^{N} \delta_j X_t + \varepsilon_t \quad (2)$$

Where

(t = 1, …, T) is time observations from 1 = 2011, T = 2015.

$InfFin_t$ is the log difference in infrastructure finance for country i at time t, and all the remaining variables are as defined earlier. We also include the lag of *InfFin* in order to take care of any possible autocorrelation in the series. For this part of the study, the proxy for financial development used is bond market capitalization as a proportion of GDP, as discussed under section 3.5.1.

3.3. Estimation Technique

3.3.1. Panel Technique

Estimation of equations 1 is carried out using panel data spanning 2000 -2015, as the data for infrastructure development is only available from 2000 and beyond. Panel data consist of cross sections observed at different points in time (Greene, 2003). Panel data allows the researcher to control for factors that can be observed, such as region, country size, location; or factors that cannot be observed or measured, such as cultural factors; or factors that change over time but not across units like national policies, domestic regulations, among others. The main advantage of panel data set over cross section is the flexibility it allows the research in modelling differences in behaviour across individuals (Greene, 2003).

If the unobserved individual effects are correlated with the regressors, then a fixed effects approach, which assumes that differences across units can be captured in differences in the constant term, is used to obtain unbiased estimates of the regression coefficients. However, if the unobserved individual effects are uncorrelated with the individual regressors, then a random effect approach is used. Hence, the main difference between the two is whether the unobserved individual or group specific effects contain elements that are correlated with the regressors in the model (Greene, 2003).

Given that the countries are expected to have different levels of infrastructure development and infrastructure finance, we could employ the fixed effects estimation technique, which allows for individual intercepts. Unlike the random effects, the fixed effects technique is known to yield consistent estimators. Moreover, since we are interested in analysing that impact of variables over time, the fixed effect model could be the best choice. However, this choice has to be informed by a formal statistical test.

To determine the choice between fixed and random effects model, the Lagrange Multiplier test and the F test, which test for the presence of the random effects and fixed effects respectively, are employed. These tests are carried out under the null hypotheses of no random effect and no fixed effects, respectively. Rejection of these null hypotheses determine which model is employed. In the event where both null hypotheses are rejected, then the specification test devised by Hausman (1978) is be employed. The null hypothesis for the Hausman test is that the coefficients estimated by the efficient random effects estimator are the same as the ones estimated by the consistent fixed effects estimator. If they are (insignificant P-value, Prob>chi² larger than .05) then it is safe to use random effects

The equations for this study are expressed as follows:

$$InfDev_{it} = z_i^{'}\alpha + \beta_1 InfDev_{it-1} + \beta_2 FinDev_{it} + \sum_{j=1}^{N} \delta_j X_{it} + \varepsilon_{it} \quad (3)$$

$$InfFin_{it} = z_i^{'}\alpha + \beta_1 InfFin_{it-1} + \beta_2 FinDev_{it} + \sum_{j=1}^{N} \delta_j X_{it} + \varepsilon_{it} \quad (4)$$

where $z_i^{'}\alpha$ is the heterogeneity or individual effect where z_i contains a constant term and a set of group specific or individual variables, which may be observed or

unobserved. $InfDev$, $FinDev$ and $InfFin$ denote growth rate of infrastructure development, growth rate of financial development and growth rate of infrastructure financing, respectively. The coefficients to be estimated are denoted as β_i.

3.3.2. GMM Technique for robustness

As a form of robustness check, equations 1 and 2 are estimated using the generalized method of moments (GMM) technique. This technique is known to be an improvement on the ordinary least squares and two-stage least squares (Hayashi, 2000). The first difference estimator or the Arellano-Bond linear dynamic estimator (Arellano & Bond, 1991) is employed in this regard, as it helps the researcher overcome the challenge of getting instrumental variables. Equations 1 and 2 can be stated in the framework of Arellano-Bond as follows:

$$InfDev_{it} - InfDev_{it-1} = \gamma_1(InfDev_{it-1} - InfDev_{it-2}) + \gamma_2(FinDev_{it} - FinDev_{it-1}) + \gamma_3(X_{it} - X_{it-1}) + (\varepsilon_{it} - \varepsilon_{it-1}) \quad (3)$$

$$InfFin_{it} - FinDev_{it-1} = \gamma_1(InfFin_{it-1} - InfFin_{it-2}) + \gamma_2(FinDev_{it} - FinDev_{it-1}) + \gamma_3(X_{it} - X_{it-1}) + (\varepsilon_{it} - \varepsilon_{it-1}) \quad (4)$$

where all variables are as defined before. By using this technique, we are able to take care of any cross-sectional fixed effects which might bias the estimates. Besides controlling for endogeneity, this approach can also account for autocorrelation by including the past levels of the dependent variable as an independent variable. One disadvantage of the first difference transformation is that it magnifies gaps, particularly, in the case of missing data (i.e. unbalanced panel). For instance, if some values of the dependent variable (say y_{it}) is missing, then both the first difference (Δy_{it}) and the lag of the first difference (Δy_{it-1}) will be missing in the transformed data (Baum, 2013). Thus, in case of missing data, we would employ the Arellano and Bover (1995) estimator, which uses forward orthogonal deviations (rather than first differences). Contrary to the first difference transformation, which subtracts the previous value from the current value, the forward orthogonal deviation

subtracts the average of all available future observations from the current value. Contrary to the first difference transformation, which drops the first observation on each individual in the panel, the forward orthogonal deviation transformation drops the last observation for each individual. It is estimable for all periods except the last period, even when there is missing data in the panel (Baum, 2013).

3.3.2. Mixed-Data Sampling (MIDAS)

Equation 2 is carried out using Mixed-data sampling (MIDAS) (Ghysels, Santa-Clara and Valkanov, 2004). A MIDAS regression allows the researcher to run a regression using a mixture of high and low frequency time-series variables. In more specific terms, the approach becomes useful when the dependent variable, which is measured at a certain frequency, can be regressed on a set of current and lagged values of independent variables measured at a higher frequency. So, in the context of this study, we can have our dependent variable (Infrastructure Finance) in quarterly frequency and independent variables (Bond market capitalization, etc.) measured at monthly frequency. By doing so, we overcome the problem of having data series of different frequency. A simple MIDAS form is expressed below:

$$InfFin_t = \beta_0 + \beta_1 B(L^{1/m}) X_{t-1}^{(m)} + \varepsilon_t \quad (5)$$

where $InfFin_t$ is the dependent variable (infrastructure finance), X is the regressor, *m* denotes the frequency of the regressor – for instance if $InfFin_t$ is annual data $X_{t-1}^{(4)}$ is quarterly – ε_t is the disturbance term and $B(L^{1/m}) = \sum_{j=0}^{j^{\max}} B(j) L^{j/m}$ is a polynomial of lag length $j^{\max}$ in the $L^{1/m}$ operator and $L^{1/m} x_t = x_{t-j/m}$. Interested readers should see Ghysels, Santa-Clara and Valkanov (2004) for further information.

3.4. Data

The present study uses country level data of annual frequency over the period 1980-2015. In total, 28 Sub-Saharan African countries are considered for this study. We restrict this study to Sub-Saharan African instead of the whole of Africa because it is the region that is known to have the most infrastructure need on the continent (Calderon, 2009). Again, the 28 countries were based on data available.

3.4.1. Financial Development

This study considers a number of proxies for financial development. The first proxy is private sector credit by deposit money banks as a ratio of total credit, which indicates the capacity of financial institutions to give loans to the private sector as well as the efficacy of the financial sector in allocating credit to the private sector (Menyah, Nazlioglu, and Wolde-Rufael, 2014; Sakyi, Boachie and Immurana, 2016). The second proxy is the ratio of broad money supply (M2) to GDP, which measures the level of monetization or financial intermediation in the economy (Calderón and Liu, 2003; Hassan, Sanchez, Yu,2011; Sakyi, Boachie and Immurana; Kodongo and Ojah, 2016). The latter is used in answering objective one. The second research objective seeks to examine the role of bond markets in promoting infrastructure development. In this regard, we employ the bond market capitalization as a proportion of GDP as proxy to examine the importance of the bond market for infrastructure development and finance. As we pointed in the literature review, deep and liquid bond markets are necessary to sustain development over a considerable number of years, as they tend to be more adept at financing infrastructure investment, government deficits and providing longer-term capital to companies for growth (Mu, Phelps, and Stotsky, 2013). It is therefore important to explore the ability of African bond markets to finance infrastructure projects. Thus, we consider this variable as the only one amendable to testing the financial development-infrastructure financing nexus. The choice of the two proxies is to avoid any possible biases that could arise from using just one proxy.

3.4.2. Infrastructure Development

In line with Kodongo and Ojah (2016), infrastructure development in this study is measured using the African Infrastructure Development Index (AIDI), developed by the AfDB (2013). The AIDI is based on four key categories: (i) Transport, (ii) Electricity, (iii) information and communications technology (ICT), and (iv) Water and Sanitation. These four components are disaggregated into nine infrastructure indicators. The choice of this index is premised on the fact that infrastructure is multi-dimensional in nature and heterogeneous across time periods and countries, hence,

it will be misleading if a single indicator (e.g. telephone density) is used to proxy for it, as it might fail to capture other dimensions (Calderón and Servén, 2010).

For instance, the transport composite index is made up of *total paved roads (km per 10,000 inhabitants),* which proxies for access to an improved road network, and *total road network in Km (Per km^2 of exploitable land area).* The electricity index is made of total electricity production of a country, including both private and public energy generated. The ICT index comprises *total phone subscriptions (per 100 inhabitants),* which has *fixed-line telephone subscription (percentage population)* and *mobile-cellular subscriptions (percentage population)* as its sub-components, and *number of internet users (per 100 inhabitants), international internet bandwidth (Mbps).* The water and sanitation composite index is also made up of *improved water source (percentage of population with access)* and *improved sanitation facilities (percentage of population with access).* Further details on the AIDI can be found in AfDB (2013). By far, this indicator captures the multi-dimensional nature of infrastructure. Moreover, with the exception of Kodongo and Ojah (2016), no other study has employed this proxy of infrastructure, to the best of our knowledge, thus making this study unique in its application.

3.4.3. Infrastructure Financing

Data for infrastructure financing is available from a number of sources, both domestic and international. For instance, the Infrastructure Economics and Finance Department of the World Bank and the Public-Private Infrastructure Advisory Facility (PPIAF) jointly host a database (commonly referred to as the PPI database[2]) of private participation in infrastructure projects across the world. The database covers data on the number of infrastructure projects as well as the total investment in all sectors (airports, railroads, roads, seaports, electricity, natural gas, telecom and water). Gutma, Sy and Chattopadhyay (2015) are among the studies that used this database.

Another source is the AidData[3] – a consortium of international development research initiatives to glean infrastructure investment data by China. China has been playing a

[2] http://ppi.worldbank.org/
[3] http://china.aiddata.org/

major role in funding infrastructure projects in Sub-Saharan Africa, particularly filling the gaps that are not met by either private sector or Official Development Finance. As indicated in figure 1 below, Ghana and Ethiopia have been the largest recipients of Chinese infrastructure financing over the past few years, receiving over $6.7 billion and $4.7 billion, respectively, between 2009-2012. Figure 2, also shows the sectoral breakdown of Chinese commitment to African infrastructure. A large part Chinese funding goes into the Transport sector (53%), followed by the energy sector (34%).

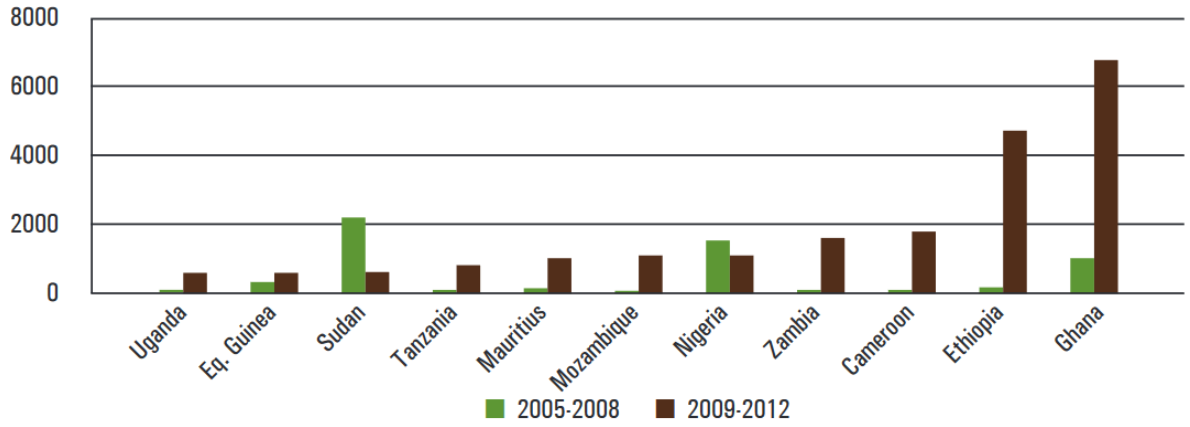

Figure 1: Chinese Infrastructure Investment Commitments in Sub-Saharan Africa, Top Recipient Countries, 2009-2012, in US$ Millions (Current)

Source: Gutma, Sy and Chattopadhyay (2015)

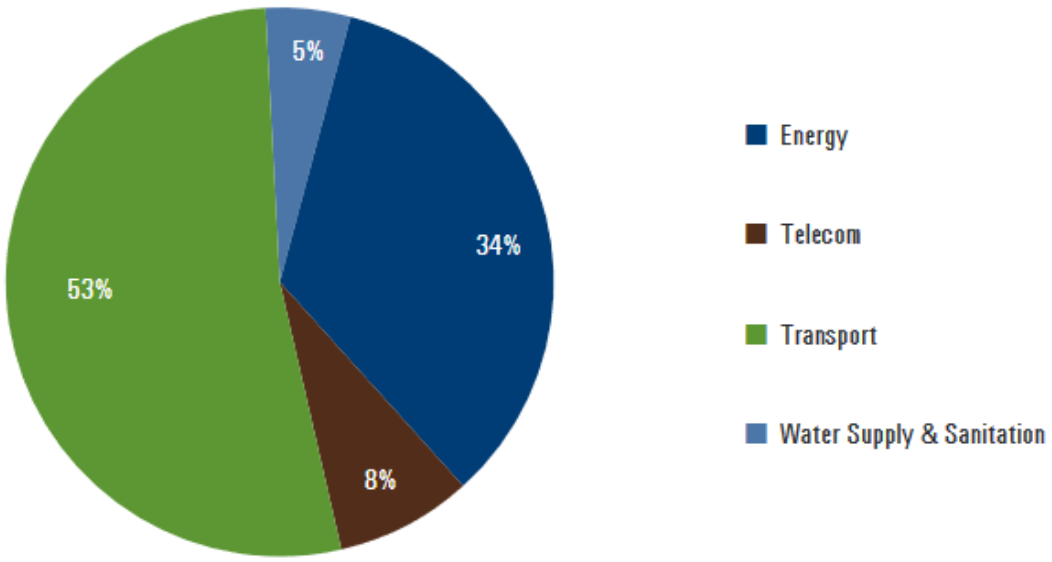

Figure 2: Chinese Infrastructure Investment Commitments in Sub-Saharan Africa, by Sector, 2005-2012

Source: Gutma, Sy and Chattopadhyay (2015)

As is mostly the case, finding the aforementioned data for African countries could sometimes be challenging. As an alternative, we use the OECD International Development Statistics (IDS) online databases[4] to glean data on infrastructure investment by institutions (World Bank and African Development Bank) and countries. Investment data from this source include official development assistance (ODA) grants and loans, other official flows (OOF) and equity investments. Investment data from this source are mainly project commitments (and not actual disbursements) in current U.S. dollars.

3.4.4. Control variables

The study also employs a host of control variables, which are known to affect infrastructure development and infrastructure finance. To begin with, the growth rate of the economy is expected to have an impact of the rate of infrastructure development, all things being equal. As noted by Randolph, Bogetic and Heffley (1996), per capita spending on infrastructure responds greatly to changes in the level of development. Pradhan, Arvin and Hall (2016) also provides evidence of both short run and long run causality among infrastructure development and economic growth. Thus, the growth rate of GDP per capita is included as one of the control variables.

According to Zhang (2005), external factors, such as political and economic risk, are crucial to the success of infrastructure projects, as they influence the public efficiency of technical approval authorities, adequacy of funding, and site limitation and location. In light of this, we include proxies for political and economic risk, sourced from the International country risk guide (ICRG) provided by the PRS Group (https://www.prsgroup.com/about-us/about-prs). Hammami, Ruhashyankik, and Yehoue (2006) also provide evidence that macroeconomic stability is essential for public-private partnerships in infrastructure.

Moreover, the World Bank has identified inadequate legal or regulatory frameworks, low credibility of government policies and lack of transparency as factors that affect public-private partnership in infrastructure projects (Asian Business, 1996; Zhang,

[4] http://www.oecd.org/dac/stats/idsonline.htm

2005). The existence of a proper legal and regulatory framework ensures the formulation of effective contractual vehicles for public-private partnerships as well as for infrastructure projects in general. Meanwhile PPPs could be stifled by over-regulation and this may eventually result in poor development of infrastructure projects. Moreover, lack of transparency may breed corruption, which could impair the progress of developmental projects. In this respect, we include institutional quality variables (legal enforcement of contracts, protection of property rights, bureaucracy cost, and control of corruption), which are known to complement development projects (Alagidede and Mensah, 2016). There are studies that find a link between the structure of country's political institutions and its economic outcomes such as improved policy environment and economic growth. More important is the link between these institutions and infrastructure investment. The prevailing argument is that the quality of a nation's institutional environment plays a critical role in attracting investment for infrastructure. The ability of a nation to credibly commit to a given policy environment is an important component in explaining investment levels within the country (Henisz, 2002; Campos and Nugent, 2000;). For instance, Henisz (2002) finds that political environments that places limits on the feasibility of policy change are essential determinant of investment infrastructure. In other words, the absence of a credible policy regime puts a country at a disadvantage in term of competing for infrastructure investment. Hammami, Ruhashyankik, and Yehoue (2006) also show that institutional quality (less corruption and effective rule of law) are important determinants of PPPs in infrastructure.

CHAPTER 4: DATA ANALYSIS AND DISCUSSION

This chapter presents the results of the study. It covers the descriptive statistics, preliminary data analysis, regression results and the diagnostic tests. The ensuing subsections discuss the results according to the set objectives.

4.1. Preliminary Data Analysis

4.1.1. Descriptive Statistics

Prior to estimation, the series were converted to natural logs (except GDP growth and inflation) and checked for stationarity using the Levin, Lin & Chu t method, under the null hypothesis of Unit root process. The test statistics are reported in Table 1 below, where rejection of the null hypothesis is indicated with asterisk (*). All the institutional variables, except control of corruption, are stationary at levels. Infrastructure development, financial development and control of corruption are stationary after first difference.

Table 1: Unitroot Test

	Levin, Lin & Chu t	
	Levels	First Difference
Infrastructure Development		-1.491*
FinDeve	-1.414	-12.502*
GDP	-5.786*	
Inflation	-6.683	
Government effectiveness	-1.675*	
Corruption	-1.065	-7.882*
Political Stability	-5.323*	
Rule of law	-3.636*	`
Regulatory Quality	-5.509*	

Note:** Probabilities are computed assuming asymptotic normality

Descriptive statistics of the variables are presented in Table 2. The maximum values of the infrastructure development index is quite high; our checks reveal that these

are linked to Seychelles (range: 47.43–93.92) and South Africa (46.07–78.97), whose infrastructure is fairly developed compared to the rest of the sub-region. We also observe that the maximum value for financial development (broad money supply to GDP) is fairly high. Checks reveal that this relates to Seychelles (range: 47.74 – 110.77) and Mauritius (range: 79.42 –106.9), whose infrastructure is fairly developed than majority of the countries in SSA. Similar to Kodongo and Ojah (2016), we observe that the fairly advanced countries tend to be more developed in terms of infrastructure and financial development.

Table 2: Descriptive Statistics

	Mean	Median	Std. Dev.	Maximum	Minimum	# Obs.
Infrastructure Development	20.960	15.190	17.280	93.920	4.100	405
Financial Development	32.420	25.350	20.570	110.77	5.74	405
GDP per capita growth	2.346	2.116	5.625	57.990	-37.925	405
Inflation	7.700	5.369	11.813	152.561	-3.503	405
Government effectiveness	-0.592	-0.627	0.627	1.036	-1.722	405
Political Stability	-0.346	-0.197	0.851	1.189	-2.370	405
Rule of Law	-0.557	-0.520	0.644	1.057	-1.855	405
Regulatory quality	-0.473	-0.464	0.564	1.123	-1.879	405
Control of Corruption	-0.56	-0.69	0.62	1.25	-1.84	405

4.2. Financial development and infrastructure development

Prior to choosing the fixed effect model, we conducted both the F-test and Hausman (1978) test to rule out the possibility of choosing the wrong model. The results presented in Table 3 below, shows the F-test along with the p-values, which indicate the presence of fixed effects. This is confirmed by the Hausman test in Table 4, whose p-values are below 0.05 and rules out the presence of random effects. Hence, we proceed to use the fixed effects model.

Table 3: Fixed Effects test

Effects Test	Statistic	d.f.	Prob.
Cross-section F	3.523	(27,347)	0.000
Cross-section Chi-square	93.0196	27	0.000

Table 4: Hausman test

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	94.881	9	0.000

We estimate the model in equation 1 using a panel of 28 Sub-Saharan African countries over the period 2000 to 2015. We begin by using the panel fixed effects estimation (Table 5) and then, as a form of robustness check, use the GMM estimation technique with both the Arellano and Bond (1991) first difference estimator (Table 6) and Arellano and Bover (1995) forward orthogonal deviations estimator (Table 7). We also report the J-statistic, which is also the Sargan statistic, in the tables. The Sargan test of over-identifying restrictions is needed to validate our instruments in the GMM estimations. Prior to carrying out the test, we check to ensure that the instrument rank for the various models are greater than the number of estimated coefficients. If this condition holds, then we construct the Sargan test of over-identifying restrictions under the null hypothesis that the over-identifying restrictions are valid. The test statistic follows a Chi-squared distribution. The accompanying p-values are greater than 0.05, confirms the validity of our instrumentation approach (Alagidede and Mensah, 2016)

The results reported in Table 5-7 show a weak positive relationship, between the variable of interest –financial development – and infrastructure development. Alongside this statistically significant positive but weak relation, the lag of infrastructure development, control of corruption (Table 7), political stability (Table 6) and GDP growth (Table 6) show statistical significance with infrastructure development. None of the other variable show statistical significance. Given that all

three models confirm the statistical significance of the target variable, the ensuing discussion is based on Tables 5-7, which show significance of the institutional variables and GDP growth, in addition. Variance inflation factor of 5 and beyond present serious multicollinearity problems. However, what is reported in Table A.1 in the appendix ranges from 1.001 to 3.282, thus indicating moderate correlation among the variables. This means a very low amount of multicollinearity.

Table 5: Panel Fixed effects model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.043**	0.010	4.466	0.000
LINDEV(-1)	-0.294**	0.052	-5.674	0.000
FINDEV(-1)	0.035*	0.016	2.215	0.027
GDP(-1)	0.000	0.000	0.369	0.712
INFLATION(-1)	0.000	0.000	0.229	0.819
GOVTEFFECT(-1)	-0.002	0.020	-0.107	0.915
CORRUPTION(-1)	-0.001	0.016	-0.049	0.961
POLSTAB(-1)	0.008	0.008	0.931	0.353
RL_EST(-1)	-0.008	0.017	-0.476	0.635
RQ_EST(-1)	-0.017	0.015	-1.115	0.266
Adjusted R-squared		0.161		
F-statistic		3.044		
Prob(F-statistic)		0.000		
Durbin-Watson		1.953		

Note: **, * denote statistical significance at 1% and 5%, respectively. The dependent variable is infrastructure development. LINDEV, FINDEV, GDP, GOVTEFFECT, POLSTAB, RL_EST and RQ_EST denote infrastructure development, financial development, gross domestic product, government effectiveness, political stability, rule of law and regulatory quality, respectively.

Table 6: Difference GMM Estimation (First difference)

	Coefficient	Std. Error	t-Statistic	Prob.
LINDEV(-1)	-0.310**	0.065	-4.807	0.000
FINDEV(-1)	0.064*	0.027	2.331	0.020
GDP(-1)	0.002*	0.001	2.480	0.014
INFLATION(-1)	0.000	0.001	0.566	0.572
GOVTEFFECT(-1)	0.002	0.018	0.084	0.933
CORRUPTION(-1)	0.001	0.019	0.028	0.978
POLSTAB(-1)	0.056**	0.019	2.925	0.004
RL_EST(-1)	-0.103	0.064	-1.603	0.110
RQ_EST(-1)	-0.055	0.041	-1.355	0.177
Instrument rank	28			
J-statistic	19.339			
Prob(J-statistic)	0.435			

Note: **, * denote statistical significance at 1% and 5%, respectively. The dependent variable is infrastructure development. LINDEV, FINDEV, GDP, GOVTEFFECT, POLSTAB, RL_EST and RQ_EST denote infrastructure development, financial development, gross domestic product, government effectiveness, political stability, rule of law and regulatory quality, respectively.

Table 7: GMM Panel Estimation (Orthogonal deviation)

	Coefficient	Std. Error	t-Statistic	Prob.
LINDEV(-1)	-0.251*	0.114	-2.202	0.028
FINDEV(-1)	0.088**	0.031	2.847	0.005
GDP(-1)	0.002	0.002	1.341	0.181
INFLATION(-1)	0.001	0.001	1.078	0.282
GOVTEFFECT(-1)	-0.018	0.037	-0.486	0.627
CORRUPTION(-1)	-0.050**	0.021	-2.364	0.019
POLSTAB(-1)	0.017	0.021	0.811	0.418
RL_EST(-1)	-0.024	0.048	-0.488	0.626
RQ_EST(-1)	-0.011	0.030	-0.366	0.715
Instrument rank	28			
J-statistic	20.787			
Prob(J-statistic)	0.349			

Note: **, * denote statistical significance at 1% and 5%, respectively. The dependent variable is infrastructure development. LINDEV, FINDEV, GDP, GOVTEFFECT, POLSTAB, RL_EST and RQ_EST denote infrastructure development, financial development, gross domestic product, government effectiveness, political stability, rule of law and regulatory quality, respectively.

As shown in tables, the coefficient for financial development ranges from 0.0351 and 0.0639 and are statistically significant in relation to infrastructure development in all cases. The statistically significant relationship reported for all cases means that past level of financial development has a positive impact on infrastructure development in subsequent years (with an average impact of about 0.06% on infrastructure development per 1 percentage change in financial development). For instance, the 0.0351 coefficient can be interpreted as follows: that a percentage increase in the level of financial development has about 0.035% impact on the level of infrastructure development in the subsequent year, all things being equal. The positive effect is in line with our *a priori* expectation but the size (small effect) justifies the need for SSA countries to focus serious attention on developing their financial markets to the extent that it can have a greater impact on infrastructure development. The extant literature (King and Levine, 1993; Beck et al., 2000; Adjasi and Biekpe, 2006; Manu et al., 2011; Kendall, 2010; Bara, Mugano and Roux, 2016) has established that financial markets and institutions have an impact on economic growth, and by implication on infrastructure development, which is a by-product of economic growth.

Surprisingly, all three equations suggest that past level of infrastructure development impacts subsequent years of infrastructure negatively. On average, there is an average of 0.28% decline in current infrastructure development level owning to the percentage change in previous year's infrastructure development. Although this is at odds with our expectations, it seems to be a reflection of the poor state of infrastructure development witnessed in most Sub-Saharan African countries. As a matter of fact, Africa's infrastructure development still mains palpable with huge gaps compared to other regions (AfDB, 2011). This huge infrastructure deficit ends up constraining growth by as much as 2% per year (Calderon, 2009) and low growth implies less resources to develop infrastructure even further. This is a vicious cycle that if not broken could lead to further deterioration of existing infrastructure.

In line with our expectations, the lag of GDP per capita growth, reported in Table 6, has a positive (0.0023, p-value= 0.0137) and statistically significant impact on current infrastructure development. The intuition is that economic growth in previous periods have the ability to shape the demand and supply of infrastructure services (Esfahani and Ramirez, 2003), which could ultimately lead to a positive impact on infrastructure

development. This finding is line with Canning and Pedroni (1999) who finds a two-way causality between the two variables.

We also examine how the presence of quality institutions affects the level of infrastructure development. The main argument is that developing the right institutions should be able to curb corruption, instil confidence in investors and ultimately have a positive influence on infrastructure development. To this end, we included various variables which institutional quality, viz. government effectiveness, control of corruption, political stability, rule of law, and regulatory quality. With the exception of the control of corruption and political stability, all other variables display an insignificant relationship with infrastructure development. We document a positive relationship between the level of political stability and infrastructure development, based on the results from table 6 (0.0555, p-value=0.0037). This implies that having a stable political environment aids infrastructural development, as there is little or no risk of drastic change in fiscal framework, which therefore promotes investment.

Conversely, we find, in table 7, that having institutions which control corruption negatively impacts infrastructure development. This is incongruent with the general assertion that high levels of corruption may lead to less transparency in implementation of infrastructure projects and hamper the flow of vital resources with dire consequences. The sharp difference between the coefficient estimate for corruption in table 5 and the equivalent one in table 7 could be as a result of estimation technique.

In sum, the findings from this section indicate that financial development is a *sine qua non* for infrastructure development in sub-Saharan African countries. In addition, having a stable political environment in addition to good levels of economic growth are prerequisites for infrastructure development. The foregoing provides answers to the first objective of this study. The next section discusses results relating to objective two.

4.3. Financial development and infrastructure finance

This section presents results based on objective two. It is worth noting that unlike the previous section, results in this section are based on time series estimations using MIDAS regression. This is mainly due to data constraints. Bond market capitalization data was only available in monthly frequency for three countries, viz. Kenya, Nigeria and South Africa. Meanwhile the proxy for infrastructure finance (ODA flows) and the other control variables were available at annual frequency. As objective two is more concerned about the impact of bond market development on infrastructure financing, we made the hard decision of running equation 2 for only the countries with sufficient data. As ODA data was available from 2011 to 2015, a period too short for time series analysis, we employed quadratic match average technique to convert the series from annual to quarterly frequency. A similar thing was done for the control variables, resulting in 20 observations each. As the bond market capitalization was already in monthly form, we had to resort to MIDAS regression (Ghysels, Santa-Clara and Valkanov, 2004).

We estimate the model in equation 2 using time series data of 3 Sub-Saharan African countries over the period 2011 to 2015. The results, reported in Table 8 -10, show no statistically significant relationship between the target variable –financial development, measured by bond market capitalization to GDP – and infrastructure finance. However, we find significant relationship between all the control variables and infrastructure finance, with the exception of Kenya, where the regulatory quality variable tends to be insignificant. It is also worth noting that the signs for some of the control variables show wrong signs, despite the statistical significance. The adjusted R-squared values show that about 99% of the variations in the dependent variable (infrastructure finance) is explained by the independent variables. The Durbin-Watson statistics is also close to 2 for all cases and this shows the absence of first order serial correlation.

In the case of Kenya (Table 8), GDP growth rate, inflation (macroeconomic stability), and government effectiveness show the wrong signs while regulatory quality is statistically insignificant. These outcomes could probably be due to our model specification. Perhaps the relationship between these variables and the dependent variable is nonlinear. We leave this for further studies. Control of corruption and

political stability are the only significant variables with the right signs. Our variable of interest, financial development, measured by bond market capitalization to GDP, turns out to be statistically insignificant even at 3 lags. Similar to Kenya, results for Nigeria (Table 9) shows no statistical significance for our main variable of interest, while wrong signs are reported for all other control variables, except inflation and government effectiveness. For South Africa (Table 10), the story is not so different; financial development ends up being statistically insignificant, wrong signs are reported for control of corruption, inflation and political stability.

The absence of a statistically significant relationship between financial development and infrastructure finance is an attestation of the general assertion that African capital markets are not so conducive to infrastructure finance. Although it is established that infrastructure finance can be boosted by robust capital markets, particularly through the creation of various financial instruments that attract investors (Ehlers, 2014), we do not find that evidence within the African space. Unlike the more advanced economies, like Australia where capital markets have an impact on the funding arrangements for economic and social infrastructure projects (Regan, Smith and Love, 2011), our finding seems to indicate that Africa's capital markets, particular the existing bond markets are still in their infancy and need to develop to the stage where they can properly finance infrastructure.

While the first set results show the importance of financial development for infrastructure development, same cannot be said of the empirical relationship between financial development and infrastructure finance from the second set of results. We also note that the effects of institutional variables in the first set of results are generally insignificant, except in few cases. Conversely, that the effect of institutional variables in the second set of results are generally significant.

Results from the preceding sections have shown that infrastructure development responds positively to greater financial development (robust capital markets). We have so far documented that this positive relationship between financial development and infrastructure development, although quite small, is significant. Conversely, we also documented that African bond markets are still not developed to the extent that they can fully support infrastructure financing, as captured for objective two. Drawing on these evidence, it is apparent that SSA countries need to consider how best to

grow the existing capital markets in order to be able to support infrastructure development and funding.

Table 8: MIDAS Results (Kenya)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.762	0.045	17.131	0.000
CORRUPTION	2.346	0.044	53.435	0.000
GDP	-0.055	0.003	-19.154	0.000
INFLATION	0.017	0.002	10.706	0.000
GOVTEFFECT	-7.064	0.074	-95.186	0.000
POLSTAB	0.516	0.017	30.022	0.000
RQ_EST	-0.108	0.147	-0.734	0.484
Page: FINDEV Series: DFINDEV Lags: 3				
PDL01	1.755	2.863	0.613	0.557
PDL02	-2.474	3.744	-0.661	0.527
PDL03	0.596	0.929	0.641	0.539
R-squared	0.990			
Adjusted R-squared	0.990			
Durbin-Watson stat	2.226			

FINDEV	Lag	Coefficient	Distribution
	0	-0.123	*
	1	-0.809	*
	2	-0.304	*

Note: The dependent variable is infrastructure finance. GDP, GOVTEFFECT, POLSTAB, RQ_EST and FINDEV denote gross domestic product, government effectiveness, political stability, regulatory quality and financial development, respectively.

Table 9: MIDAS Results (Nigeria)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.177	0.016	-71.963	0.000
CORRUPTION	-6.344	0.077	-82.685	0.000
GDP	-0.033	0.001	-73.694	0.000
INFLATION	-0.024	0.000	-61.380	0.000
GOVTEFFECT	2.949	0.029	101.097	0.000
POLSTAB	-0.596	0.010	-57.519	0.000
RQ_EST	-0.348	0.016	-22.488	0.000
Page: FINDEV Series: DFINDEV Lags: 3				
PDL01	-1.881	4.241	-0.444	0.669
PDL02	2.473	5.017	0.493	0.635
PDL03	-0.664	1.220	-0.545	0.601
R-squared	0.998			
Adjusted R-squared	0.997			
Durbin-Watson stat	1.304			

FINDEV	Lag	Coefficient	Distribution
	0	-0.072	*
	1	0.409	*
	2	-0.438	*

Note: The dependent variable is infrastructure finance. GDP, GOVTEFFECT, POLSTAB, RQ_EST and FINDEV denote gross domestic product, government effectiveness, political stability, regulatory quality and financial development, respectively.

Table 10: MIDAS Results (South Africa)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.062	0.132	-8.023	0.000
CORRUPTION	-5.361	0.508	-10.559	0.000
GDP	0.083	0.006	13.393	0.000
INFLATION	0.025	0.005	4.608	0.002
GOVTEFFECT	6.626	0.359	18.436	0.000
POLSTAB	-4.704	0.352	-13.380	0.000
RQ_EST	1.602	0.216	7.421	0.000
Page: FINDEV Series: DFINDEV Lags: 4				
PDL01	4.168	3.907	1.067	0.317
PDL02	-2.524	4.397	-0.574	0.582
PDL03	0.500	0.859	0.582	0.577
R-squared	0.999			
Adjusted R-squared	0.999			
Durbin-Watson stat	1.590			

FINDEV	Lag	Coefficient	Distribution
	0	2.145	*
	1	1.122	*
	2	1.100	*
	3	2.079	*

Note: The dependent variable is infrastructure finance. GDP, GOVTEFFECT, POLSTAB, RQ_EST and FINDEV denote gross domestic product, government effectiveness, political stability, regulatory quality and financial development, respectively.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

This study set out to achieve the following objectives:

i. Examine the relationship between financial development and infrastructure development in Sub-Saharan Africa.
ii. Examine the relationship between specific aspects of financial development (e.g. bond markets) and infrastructure financing in Sub-Saharan Africa.

Objective one employs panel data comprising of 28 African countries spanning the period 2000 to 2015. Panel fixed effects was used and results confirmed with GMM using both difference and orthogonal deviation. Results indicate the financial development has a positive and statistically significant effect on infrastructure development. The relationship is, however, weak, which suggests that more needs to be done to improve financial markets in order for them to make greater impact on infrastructure development. The results also show that GDP per capita growth and political stability have a positive impact on financial development, suggesting that having a good growth trajectory and a stable political environment matters. However, we find that control of corruption variable is significant but surprisingly has a negative impact on infrastructure development.

Objective two focuses on bond market development and how it affects infrastructure financing. Initially, we had thought of using a panel approach, similar to objective one. However, this could not be achieved because bond market data was available at monthly frequency for only three countries (Kenya, Nigeria and South Africa). All other data was available at annual frequency for only five years. As a result, we resorted to MIDAS regression that enables us to estimate regression using data at different frequencies. Quadratic-match average technique was used to convert the annual data into quarterly, in order to have adequate number of observations for time series analysis. The results show no statistical relationship between financial development, measured by the ratio of bond market capitalisation to GDP, and infrastructure finance. This finding seems to suggest that African bond markets need to develop further before they can have significant impact on infrastructure finance. Other control variables, such as GDP per capita growth rate, inflation (measure of

macroeconomic stability) and government effectiveness are found to have significant impact on infrastructure finance, although some showed wrong signs.

We contributed to the emerging literature that examines the nexus between financial development and infrastructure development and financing. Nonetheless, significant areas remain to be explored further. For instance, it could be immensely useful if future research could examine nonlinearities in the financial development-infrastructure development and finance nexus. To this end, future studies could employ nonlinear models to explain the relationships examined in this study. Our analysis of the nexus between bond market development and infrastructure financing was limited due to lack of data for many African countries. As data becomes available, it would be interesting if the bond-market development –infrastructure finance nexus is extended to more African countries. In addition, future research could include alternative proxies for bond market development.

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Appendix

Table A.1. Variance Inflation Factors

	Coefficient	Uncentered VIF	Centered VIF
Variable			
LINDEV(-1)	0.003	2.120	1.006
FINDEV(-1)	0.000	1.114	1.060
GDP(-1)	0.000	1.304	1.083
INFLATION(-1)	0.000	1.972	1.180
GOVTEFFECT(-1)	0.000	1.269	1.269
CORRUPTION(-1)	0.000	1.312	1.312
POLSTAB(-1)	0.000	3.282	1.544
RL_EST(-1)	0.000	2.180	1.619
RQ_EST(-1)	0.000	2.677	1.291