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Infrastructure Financing in a Developing Economy: Addressing the Electricity Supply Deficit in Swaziland

Submitted to:



In partial fulfilment of the requirements for the degree of
Master of Management in Finance & Investment Management.

By:

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Abstract

This study examines the relationship between electricity infrastructure finance and the economic growth of Swaziland in an attempt to determine the extent to which electricity infrastructure contributes to economic growth. The study also examines what factors determine the level electricity infrastructure finance in Swaziland, and the extent of the influence of these factors. This study hopes to add to the body of literature focused on scrutinising the infrastructure investment challenges in the low-income countries of the African region, and the discovery of innovative financing mechanisms that will bring the region to a favourable position where it can supply reliable energy that promotes the prosperity of its people. Using annual data, trend analysis and OLS regression techniques are applied to determine the extent of the relationship between electricity infrastructure investment and economic growth, as well as the economic and regulatory factors expected to influence the level of infrastructure investment, as suggested by literature. The level of electricity infrastructure investment is found to be positively correlated with economic growth and the macroeconomic stability of Swaziland. However, little to no correlation is found between the level of electricity infrastructure investment, and government revenue, stock market capitalization, and credit extended to the government and parastatals. Regulatory quality is found to be negatively correlated to electricity infrastructure investment.

Declaration

I, Simphiwe Khumalo, declare that the research work reported in this dissertation is my own, except where otherwise indicated and acknowledged. It is submitted in partial fulfilment for the Masters of Management in Finance and Investments degree at the University of the Witwatersrand. This has not been submitted before for any degree or diploma at any other university or institution for a similar qualification.



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Abbreviations

AfDB	African Development Bank
CBS	Central Bank of Swaziland
CSP	Country Strategy Paper
DAM	Day Ahead Market
EDM	Electricidade de Moçambique
EIU	Economist Intelligence Unit
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GWh	Gigawatt Hour
IPPs	Independent Power Producers
MDGs	Millennium Development Goals
MNRE	Ministry of Natural Resources and Energy
MW	Megawatt
OLS	Ordinary Least Squares
PPI	Private Participation in Infrastructure
PPP	Private-Public Partnerships
SACU	Southern African Customs Union
SAPP	Southern African Power Pool
SEC	Swaziland Electricity Company
SERA	Swaziland Energy Regulatory Authority
SSA	Sub Saharan Africa
UN	United Nations
UNDP	United Nations Development Program

Chapter 1: Introduction

1.1. Background

With a majority of the fastest growing economies in the world being in Africa, the continent shows the greatest promise in taking the lead with regards to economic growth. Foster and Briceno-Garmenda (2010) agree that the continent's growth has improved markedly over the last decade, driven mainly by rising commodity prices through resource-rich countries. This growth, however, has pushed infrastructure to its limits in most African states, as evidenced by the prevalence of load shedding in South Africa since 2008. Infrastructure has played a major part in Africa's economic performance and will need to play an even greater role to attain the continent's development goals (Foster, 2008).

Developing countries around the world face many factors that limit them in reaching their potential with regards to economic growth and achieving their development goals. Corruption, crime, political instability, and under-developed financial markets are amongst the biggest constraints holding back economic growth. The negative effects of inadequate infrastructure (whether qualitatively or quantitatively) are at least as large as those of the above mentioned factors. Although initially ahead, Sub Saharan Africa has fallen significantly behind South Asia with regards to the provision of key infrastructure to exploit its full economic growth potential and, by extension, reducing poverty. Nowhere is this shortfall particularly visible than in the power sector. According to Foster (2008), South Asia has almost twice the generation capacity per million people compared to Sub Saharan Africa, while just three decades ago, Sub Saharan Africa had almost three times as much as South Asia. Table 1.1 (Adapted from Foster & Briceno-Garmenda, 2010 to include percentage deficit) compares low-income countries in Sub Saharan Africa against low-income countries from the rest of the world. The 88.7 percent deficit in generation capacity clearly illustrates Foster's statement.

Foster goes on to mention that in the power sector – whether measured in terms of generation capacity, electricity consumption, or security of supply – is where Africa's largest infrastructure deficit is found. Infrastructure is not only a major hindrance in doing business, but also negatively impacts on many social issues because of its importance as an input to the health and education services, access to information, and the productivity of small businesses.

Normalized units	Sub-Saharan Africa low-income countries	Other low-income countries	% Deficit
Paved-road density	31	134	-76.9
Total road density	137	211	-35.1
Main-line density	10	78	-87.2
Mobile density	55	76	-27.6
Internet density	2	3	-33.3
Generation capacity	37	326	-88.7
Electricity coverage	16	41	-61.0
Improved water	60	72	-16.7
Improved sanitation	34	51	-33.3
Note: *Road density is measured in kilometres per 100 square kilometres of arable land; telephone density in lines per thousand population; generation capacity in megawatts per million population; electricity, water, and sanitation coverage in percentage of population.*			

Adapted from Source (Foster & Briceno-Garmenda 2010)

Table 1.1: Africa's Infrastructure Deficit

In the beginning the 21st century, the United Nation's member states proposed eight broad goals in response to key development challenges outlined in the Millennium Declaration. These goals were referred to as the Millennium Development Goals (MDGs). Although Africa's growth has been relatively good over the past decade, it is still not good enough to achieve the sizeable poverty reduction necessary to attain the MDGs – a key ingredient to achieving all the Millennium Development Goals is infrastructure (Foster & Briceno-Garmenda, 2010).

Strategic infrastructure deficits continue to pose substantial challenges in low-income countries (Bhattacharya, Romani, and Stern, 2012). One such country within the Southern African Development Community is Swaziland. This small open economy has struggled to achieve an economic growth rate above 2.5 percent since 1992. The country's categorization as a lower middle-income country masks its social challenges, such as poverty and inequality (African Development Bank, 2013). At least 65 percent of the country's population are living below

the poverty line, particularly in non-urban areas – where infrastructure development is at its lowest. Although much has been achieved in increasing access to electricity in rural areas, more than seventy percent of Swaziland's annual electricity consumption is still imported from neighbouring countries. The Swaziland Electricity Company's Annual Report 2013/14 indicates that, of the 1 212.6 GWh distributed during the year, only 347.1 GWh was produced locally. This attributes only 28.6 % to local generation, and the rest is imported from South Africa's Eskom (61.1%), Mozambique's EDM (8.5%), and the South African Power Pool's DAM (1.7%).

According to the African Development Bank's Country Strategic Paper for Swaziland 2014-2018, one of the pillars that will help achieve a sustained high economic growth rate is infrastructure development. There is therefore little doubt that it is critical that the infrastructure deficit – particularly in the power sector – be addressed with great urgency if the country is to pull itself out of its low-growth trap.

1.2. Problem Statement

The first problem this research has identified is the lack of sufficient electricity generation infrastructure to meet Swaziland's current and future power demand. By the end of 2014, Swaziland's installed generation capacity stood at 79.6 MW – of which 69.6 MW is owned and operated by the Swaziland Electricity Company (SEC), while the rest is that part of Illovo's Ubombo Sugar mill cogeneration plant capacity that is available to the national grid. During the same year, SEC reported the country's peak power demand to be 221.7 MW.

Exacerbating the problem is that, besides the fact that 9.5 MW of SEC's installed capacity consists of diesel generators that have essentially been put out of service, most of the capacity is made up of hydro power generation that is dependent on a highly intermittent and seasonal resource. For the last five years (2010 - 2014), the SEC has only managed to contribute an average of 25.2 % of the country's total annual electricity consumption.

According to Bhattacharya et al. (2012), in order to meet the development requirements for developing countries, infrastructure investment spending will need to more than double by 2020. A large share of this spending will have to be directed towards the power sector since

the highest deficit lies there. Currently, most of the almost $1 trillion per year infrastructure spending in developing nations is financed by domestic budgets.

The second problem is the lack of financing to address the electricity infrastructure deficit – mainly due to a constrained fiscal budget and lack of functional public private partnerships. For Swaziland, the limited fiscal problem is further compounded by the economy's dependence on the Southern African Customs Union revenues. About fifty percent of the fiscal budget is funded through the SACU revenues. Because of the volatility of this revenue stream, especially over the last few years, the Swazi government needs to urgently find innovative ways, not only to diversify its revenue sources, but also to fund its infrastructure deficit.

According to the AfDB's Country Strategy Paper (CSP) for Swaziland 2014-2018, one of the country's major challenges is inadequate investments for maintaining and developing infrastructure, including those relating to transport, electricity, and telecommunications.

1.3. Study Objective

The broad objective of this study is to probe the financing challenges, and possible solutions, within the electricity infrastructure sector in Swaziland. The study will attempt to achieve this broad objective by focusing on the following specific objectives:

1. Identify the extent of the relationship and interaction between the level of infrastructure investment and the economic growth in the context of Swaziland.

2. Identify domestic, regional, and international factors affecting the level of infrastructure investment in Swaziland's electricity sector, particularly investment in generation capacity, and the extent of the influence of these factors.

3. Examine innovative financing mechanisms applied by other developing countries, and developed economies, to determine which of these would be feasible and sustainable for the Swazi context, taking into consideration the unique challenges the country faces.

4. Assemble a financing solution for increasing sustainable investment in generation capacity for Swaziland that incentivizes all stakeholders to fully participate, while positively contributing towards achieving the country's economic goals.

1.4. Significance of the Study

One of the key policy objectives for the government of Swaziland is to ensure continued improvement of the electricity supply infrastructure as part of the strategy for attracting foreign direct investment (Camco & Renewable Energy Association of Swaziland, 2009). This study will therefore provide useful information that will assist the Ministry of Natural Resources and Energy, and other organisations like the Swaziland Electricity Company, to develop innovative financing mechanisms towards reducing the electricity supply infrastructure gap.

This study also aims to add to the body of literature focused on scrutinising the infrastructure investment challenges in the low-income countries of the African region, and the discovery of innovative financing mechanisms that will bring the region to a favourable position where it can supply reliable energy that promotes the prosperity of its people. Mostafavi, Abraham, and Sinfield (2014) describe financial innovation as "development of new financing systems that complement traditional systems to address existing challenges and to enhance economically sustainable global infrastructure".

Ultimately, this study hopes that addressing the infrastructure deficit will positively impact the economic growth of Swaziland – leading to the reduction of unemployment and the eradication of poverty. At least 65 percent of the country's population are living below the poverty line, particularly in rural areas – where infrastructure development is at its lowest. Also, this study hopes to fill a gap in literature with regards to the examination of development finance challenges, specifically in the power sector of low to medium income developing economies within Sub Saharan Africa.

Chapter 2: Literature Review

2.1. Introduction

Reducing Africa's infrastructure deficit will require a significant investment effort. According to Bhattacharya et al. (2012), in order to meet the development requirements for developing countries, infrastructure investment spending will need to more than double by 2020. By addressing this infrastructure gap, developing economies will be able to achieve and sustain the significant economic growth necessary to overcome their prevailing socio economic challenges. Helm (2009) highlights the importance of infrastructure as fundamental conditions for economic activity. He argues that infrastructure, such as transport and energy, are necessary for the economy to function because they allow access to the market, and are also key resources and inputs to the production function.

2.2. Infrastructure Development and Economic Growth

Several studies have argued the importance of infrastructure to economic growth. In a study where they investigate the role of infrastructure in economic growth in India, Sahoo and Dash (2009) acknowledge that the role of infrastructure is important in maintaining growth momentum because of the strong relationship between infrastructure and economic growth. In an empirical study of 44 African countries to explore the effect of telecommunication infrastructure on economic growth, Batuo (2015) finds that the telecommunications infrastructure variable is positively correlated to regional economic growth.

Because empirical research investigating the effect of infrastructure on economic growth has usually faced the challenge of endogeneity and reverse causality, Sahoo and Dash (2009) carry out a Granger causality test at first difference to establish the direction of causality between infrastructure and GDP growth. They conclude that a one-way causality exists that runs from infrastructure to growth, and find no reverse causality from GDP growth to infrastructure. Chotia and Rao (2015) construct a composite infrastructure index using indicators relating to health, education, transport, agriculture, and energy to evaluate the relationship between infrastructure and economic growth. This analysis also finds infrastructure growth to be strongly related to economic growth. Sahoo and Dash (2009) further argue that energy, electricity, and road infrastructure make the most contribution to growth, hence are the most

important infrastructures in the context of economic growth. Kodongo and Ojah (2015) suggest that about half of the funding necessary to close Sub Saharan Africa's infrastructure gap would need to be directed towards the power sector. Developing economies therefore have to direct a large share of future infrastructure spending towards these infrastructure if good economic growth is to be achieved and sustained over the long term.

Kodongo and Ojah (2015) use panel data of forty Sub Saharan Africa countries from the World Development Indicators and the UNDP to construct two infrastructure indexes (stock and quality), and use the generalized method of moments to examine the relationship between infrastructure and economic growth. The results of their study indicate that, for the SSA region, it is the quality of the infrastructure that is more likely to stimulate economic growth, rather than a change in infrastructure stock. This suggests that the maintenance of infrastructure should be the priority for African governments, before investment in expansion. The deterioration of infrastructure, due to the disregard of maintenance, negatively impacts economic growth due to the reduction of an economy's productive capacity. Also, besides the additional, immediate, cost to the user, infrastructure failure can cause larger expenditures in the future (Rioja, 2001).

The nature of infrastructure projects is such that they exhibit long lead times, high costs, and mostly indirect return on investment. The combination of these characteristics mean that the benefits of investment in infrastructure will not influence economic growth for a number of years. In a study to analyse whether economic growth can be positively influenced by government through spending focused on infrastructure, C. Yanushevsky and R. Yanushevsky (2013) advise that, in pursuit of economic growth through investment in infrastructure, a government can reach a dangerously high debt to GDP ratio. They further argue that in order to limit the burden on already constrained fiscal budgets, innovative new funding mediums need to be found to adequately fund public infrastructure. Kirkpatrick, Parker, and Zhang (2006) suggest that the potential role of infrastructure in developing countries as a key ingredient for economic growth and sustainable development has not been fully exploited, hence its contribution to poverty reduction has not been realized.

2.3. Determinants of Infrastructure Investment

Arimah (2005) uses UN-Habitat's Global Urban Indicators data to examine variations in infrastructure spending in developing economy cities across parts of Africa, Asia, the Middle East, Latin America, and the Caribbean. The purpose of this empirical study is to determine what factors drive infrastructure spending. The results of the study suggest that investment in infrastructure is lowest in Africa and Asia, and also that the variations in infrastructure investment can be explained by differences in the macroeconomic environment, quality of governance, and the government's financial capacity. Arimah (2005) also finds that infrastructure spending increases with an increase in the government's revenue proportion derived from taxes, user fees, and the capital markets.

Besides the competing, and often conflicting, demands placed on the fiscal budget, most of the current infrastructure spending in developing economies is financed through domestic budgets. A further constraint to the fiscal budgets is the introduction of the so called debt ceilings aimed at controlling debt levels. Consequently, many governments find themselves with ever increasing infrastructure deficits, yet they cannot afford to increase infrastructure spending – regardless of the clear and urgent need to invest in infrastructure to promote growth. Gupta, Clements, Baldacci, and Mulas-Granados (2006), in a study to examine the relationship between fiscal adjustment, expenditure composition, and economic growth in low-income countries, find that a strong relationship exists between fiscal adjustment and economic growth such that a 2 percentage points reduction of the average fiscal deficit to GDP, could increase per capita growth by up to 2 percentage points. Therefore, "tilting the overall composition of public expenditure toward more productive uses is particularly important for boosting growth" Gupta et al. (2006). They further argue that during a fiscal adjustment, those expenditures that lead to higher economic growth (such as infrastructure spending) should be best protected.

To maximize the benefits of economies of scale and scope in delivering services, infrastructure industries, such as telecommunications, water, and electricity, have naturally been characterized by monopolies. Kirkpatrick, Parker, and Zhang (2005), argue that this monopoly characteristic has resulted in inefficient state-owned enterprises that have little regard for consumers. As a consequence, privatisation of these state-owned enterprises, either in whole or in part, has been increasingly introduced to improve the efficiency of service delivery. However, privatisation risks the introduction of private sector monopolies (Kirkpatrick et al.,

2006) that if left unregulated and with little or no competition, can aggressively pursue profit maximization with little regard for consumer welfare. Government, therefore, needs to build strong regulatory capabilities to protect consumers from such monopolies. In agreement, the World Bank suggests that it is effective regulation, rather than the structure of ownership, that is the most effective infrastructure reform (Kirkpatrick et al., 2005). In trying to answer the question of what the ideal sequencing of reforms in electricity generation is, Zhang, Parker, and Kirkpatrick (2004) use data from 25 developing countries for the period 1985 to 2001 to study the effects of the sequencing of privatisation, competition, and regulation reforms. This study finds that higher electricity generation and capacity are correlated with the formation of an independent regulatory body and the introduction of competition before privatisation. Rarely has a country felt comfortable with the simultaneous introduction of all the three reforms (Zhang et al., 2004). Therefore, introducing an independent regulator and competition before privatisation is likely to result in increased electricity generation capacity and improved availability. Helm (2009) suggests that privatization can be regarded a possible solution to the under-investment in infrastructure by the public sector, and the access to private capital markets would ease the pressure on the fiscal resources.

Kirkpatrick et al. (2005) provide empirical evidence of the effect of regulation on FDI in infrastructure in 16 Asian low and medium income countries. Data on foreign direct investment obtained from the World Bank's Private Participation in Infrastructure database is regressed on a measure of regulatory institutional quality. The results show the proxy for regulatory quality to have a positive sign and to be statistically significant, illustrating that the quality of the regulatory environment positively influences foreign investors to invest in infrastructure projects in developing economies. There was, however, little evidence supporting the influence of independent utility regulation – an indication that it is the quality of the overall governance environment that influences the decisions of foreign investors to invest in infrastructure, rather than the presence of an independent utility regulatory authority. Even so, utility regulation, that is independent from political influence, is a key requirement for the success of privatisation to "establish a policy environment that sustains market incentives and investor confidence" (Kirkpatrick et al., 2005).

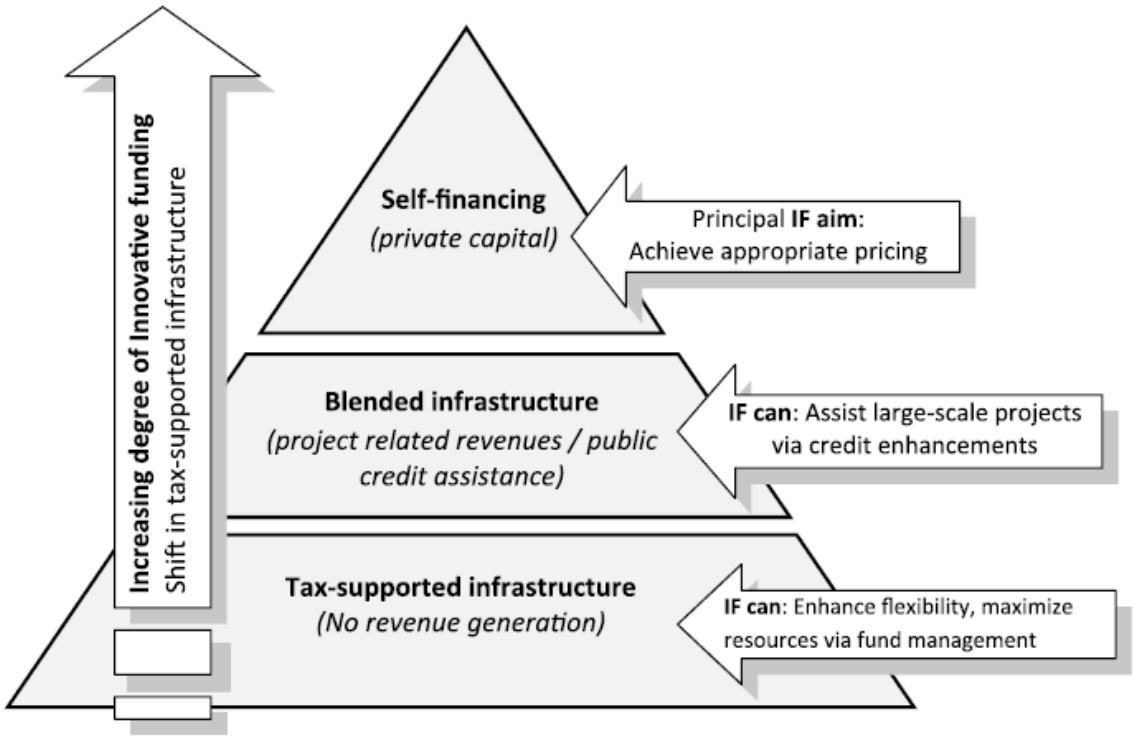
The leading innovative financing mechanism for infrastructure is the collaboration between public and private finance. However, the success of Private-Public Partnerships (PPPs), as an alternative to the pure public finance for infrastructure development, is heavily dependent on

access to credit and capital markets. “The fundamental role played by the financial sector is to facilitate the reallocation of funds from agents (individuals) with an excess of capital, given their investment opportunities, towards agents (firms) with a shortage of funds, given their investment opportunities.” (Rajan and Zingales, 1996). Kirkpatrick et al. (2005) affirm that financing of large scale private investments is compromised in countries where financial markets are relatively underdeveloped and inefficient. In a paper discussing the state and progress of African capital markets with regards to reaching a point of attracting substantial foreign investments, Khumfula (2005) argues that the poorly organized capital markets of many developing countries, are regarded as ineffective in mobilizing capital for infrastructure investment. To improve this situation, the paper recommends several solutions, such as the removal of obstacles to capital market development, implementation of sound economic policies, and the integration of capital markets.

2.4. Alternative Finance for Infrastructure Development

Kodongo (2013) argues that there are several innovative funding options available to Sub Saharan African countries – such as Diaspora bonds, infrastructure bonds, and Public-Private Partnerships. However, in a study to explore the impact of increasing infrastructure spending in six SSA nations, Estache, Perrault, and Savard (2012) note the importance of selecting the most appropriate infrastructure funding mechanism. They argue that implementing inefficient funding schemes could ultimately reduce the potential positive impact of public infrastructure. Mostafavi et al. (2014) define financial innovation as the “development of new financing systems that complement traditional systems to address existing challenges…”, but also warn however, that this definition can vary within the context that it is being evaluated in. In agreement, Badu, Owusu-Manu, Edwards, and Holt (2013) state that innovative finance includes “tools and techniques that supplement traditional financing sources and methods”.

The role of innovative finance, in the context of infrastructure finance, is to reduce the infrastructure deficit – that is prevalent in developing economies – while simultaneously reducing the burden on government to finance infrastructure development entirely from their heavily constrained resources. Badu et al. (2013) illustrate, using figure 2.1 below, how effective innovative finance should ease the dependence on state revenues and look increasingly towards the private sector to fund infrastructure development. Also illustrated, are the innovative finance tools that can be applied as the degree of innovative finance increases.



Source: Badu et al., 2013

Figure 2.1: Applicability of Innovative Finance Tools

Although infrastructure finance through other sources – either than the public finance – has been on the increase, progress has been hindered by potential problems that challenge the feasibility of these alternatives. For this reason, Estache, Serebrisky, and Wren-Lewis (2015) find it useful to step back and rethink the decision making process that needs to be undertaken to evaluate the scope and limits of Private-Public Partnerships (PPPs). They try to answer the question of when private finance should be used, and when public finance should be used by developing countries. In an examination of the determinants of infrastructure indicators in developing economies, Dao (2008) illustrates that both public saving and private investment have a positive and statistically significant effect on energy and telecommunication infrastructure.

Arimah (2005), suggests that the public sector will maintain its role as a major player in the provision of infrastructure. He argues that because of the profit-oriented nature of the private sector, there is some reluctance in taking on the risk of financing long-term infrastructure projects. However, in an empirical examination of the relationship between public and private investment, Erden (2006) finds that for every 1 percent increase in public investment, private

investment increases by 0.54 percent. This complementary relationship between public and private investment supports the popularity of Private-Public Partnerships as an alternative channel for infrastructure finance.

A stand out potential issue with alternative finance mechanisms is the high cost of these instruments and, by extension, the question of who will bear this cost. Perhaps the more pertinent question is – with most of the population in the developing world living below the poverty line, can they afford to bear the cost of financing infrastructure without fiscal assistance? Estache (2010) notes that any attempt at full cost recovery would be harshest in the poorest regions in which the infrastructure access gaps are also largest, and would see up to 35 percent of the average citizen's income go toward paying their share of total infrastructure costs. User fees are progressively becoming a key alternative source of finance in developed economies, but again, due to the unique socio-economic, technical, and institutional challenges, they continue to be difficult to implement effectively in the developing world (Arimah, 2005). At just 18 percent of GDP, (Gumede, Monyae, and Motshidi, 2012) argue that even the collective savings of Africa's citizens are not sufficient to fund the continent's development.

Govorkyan (2008) offer a basic definition of Diaspora to be "a group of people dispersed outside its traditional homeland". According to the African Union, African diaspora includes "the peoples of African origin whose ancestors within historical memory came from Africa, but who are currently domiciled in other countries outside the continent…" (Gumede at al., 2012). Because of their rise in economic status in the foreign countries, Diasporas are increasingly seen as potential alternative sources of finance by their home countries. One way of accessing the accumulated wealth of these Diasporas is through the issuance of bonds. However, as a long-term development financing instrument, diaspora bonds have not gained much popularity (Ketkar and Ratha, 2007), this is despite the fact that these bonds are viewed to provide an easier path to access international capital markets. Kodongo (2013) views Africa's inexperience with diaspora bonds, the misuse of public funds, as well as the lack of accountability in a number of African states as obstacles for governments to effectively use this potentially large resource for infrastructure development finance. African Diaspora Infrastructure Bonds, if implemented well, would not only contribute to the continent's growth, development, and increase employment, but would also instil some level of patriotism in the African Diaspora (Gumede et al., 2012).

Feed-in tariffs have gained popularity globally in the recent past as an incentive to encourage investment in renewable electricity infrastructure. Mabee, Mannion, and Carpenter (2011) define feed-in tariffs within this context as "an agreement to pay a guaranteed amount for every kWh over a set period of time for certain types of renewable electricity, encouraging investment from both small and large-scale generators". Also known as 'advanced renewable tariffs', feed-in tariffs have become important policy instruments for many governments because they have been empirically proven to reduce the cost of investment in renewable electricity, hence an increase of renewable energy power (Mendonca, 2009). In a survey conducted on fund managers from 60 fund management firms to examine the effectiveness of policy approaches aimed at increasing renewable energy power, Burer and Wustenhagen (2009), use a stated-preference approach to collect information from the participants. The results of this study suggest that feed-in tariffs are seen to be a significantly effective tool at encouraging investment in new renewable energy technologies.

By design, feed-in tariffs bring predictability and the long-term security necessary to allow energy infrastructure investments to be of lower risk, thus allowing potential investors to confidently invest the large amounts of resources required to develop such infrastructure. Because of comparatively higher transparency, lower administration costs, and simplicity, feed-in tariffs also attract a higher number and variety of investors (Mendonca, 2009). Feed-in tariffs are structured to encourage technological development (Mabee et al., 2011) and economies of scale, such that a point is reached where supporting the renewable energy industry is no longer necessary (Mendonca, 2009). A major consideration for such a policy is that the cost is usually passed on to the consumer and can thus result in customer backlash if tariff prices are set too high. By placing more focus on lowering investment costs, and avoiding windfall profits, good feed-in tariffs would lower the cost for the final consumer (Mendonca, 2009). Mabee et al. (2011) contend, however, that lowering the cost of electricity generation should not be the goal of a successful feed-in tariff policy, but rather to promote the use of a variety of renewable electricity sources. It is therefore important that the tariff be set such that the goals of the policy are reached without unreasonably increasing costs for consumers. Lesser and Su (2007), argue that, although setting feed-in tariff rates too low would result in failure to meet renewable energy technology targets, setting rates too high would increase electricity prices, thus reducing economic well-being.

2.5. Regional Overview

Infrastructure has played a major part in Africa's economic performance and will need to play an even greater role to attain the continent's development goals (Foster, 2008). If fact, more than half of Sub Saharan Africa's positive growth in the decade before the 2008 global recession can be attributed to infrastructure (Foster and Briceño-Garmendia, 2010). This growth, however, has pushed infrastructure to its limits such that it has become a constraint on SSA's development. Aggravated by poor quality infrastructure and finance inefficiencies, the infrastructure deficit has continued to increase to a point where an average of at least 12 percent of GDP is necessary to finance infrastructure investment. For low-income countries, 20 percent of GDP would need to be committed to meet their infrastructure needs (Foster, 2008).

The largest deficit lies in the power sector (Foster, 2008), where up to 40 percent of the $93 billion needed to overcome the infrastructure deficit would need to be directed. About 7000MW additional power capacity per annum is necessary to match Sub Saharan Africa's economic growth. Eberhard et al. (2008) argue that addressing the region's power sector stock and quality deficiencies would boost per capita economic growth by an average of 2.2 percent. The prevailing deficiencies in the power sector have also been a major contributor to the high cost of infrastructure services in the region. This has resulted in the average price of power being several multiples of those in other developing regions (Foster and Briceño-Garmendia, 2010). Eberhard et al. (2008) further argue that prices are often not high enough to cover costs because of governments' sensitivity to popular sentiments against price increases. This implies that prices should even be higher for SSA countries to at least maintain the quality of existing infrastructure.

Although public budgets are increasingly constrained by the poor socio-economic conditions in SSA countries, public finance remains the primary source for infrastructure development finance. The public sector is responsible for as much as two-thirds of overall spending in infrastructure – mainly in water, energy, and transport sectors (Foster and Briceño-Garmendia, 2010). Gutman, Sy, and Chattopadhyay, 2015 argue, however, that non-public financing for infrastructure in SSA has tripled in the eight years preceding 2013. They further state that the energy sector has shown the fastest growth recently, and now commands at least 45 percent of overall external finance. This surge in the contribution of private finance in infrastructure has brought about unique challenges and opportunities for the SSA region.

As a way of attracting more non-public financing for infrastructure, private participation in infrastructure (PPI) has grown over the last ten years at a robust rate of 9.5 percent to account for more than 50 percent of all external financing (Gutman et al., 2015). Eberhard et al. (2008) argue, nevertheless, that the poor pace of reform in SSA has meant state-owned utilities remain dominant in the market, hence private sector participation is either temporary or marginal – in the form of independent power producers (IPPs). Furthermore, a majority of PPI in SSA is skewed towards the telecoms sector because of clear costs and lower risk during development. However, Gutman et al. (2015) note that investment in electricity generation shows the fastest growth.

Key to reducing the infrastructure deficit in SSA is addressing reform and regulatory issues, and overcoming inefficiencies. Achieving this, through better maintenance of infrastructure, and regulatory and institutional reform at utilities, would reduce the estimated $93 billion required annually to fill the infrastructure gap by $17 billion (Gutman et al., 2015).

2.6. Swaziland Electricity Industry

The state-owned Swaziland Electricity Company is the dominant player in the country's electricity industry. Although there are a number of private generation plants, SEC is the sole owner and operator of the transmission grid, and is also responsible for the commercial distribution of electricity. By the end of 2014, Swaziland's installed generation capacity stood at 79.6 MW – of which 69.6 MW is owned and operated by the SEC, while the rest is that part of Illovo's Ubombo Sugar mill cogeneration plant capacity that is available to the national grid. During the same year, SEC reported the country's peak power demand to be 221.7 MW.

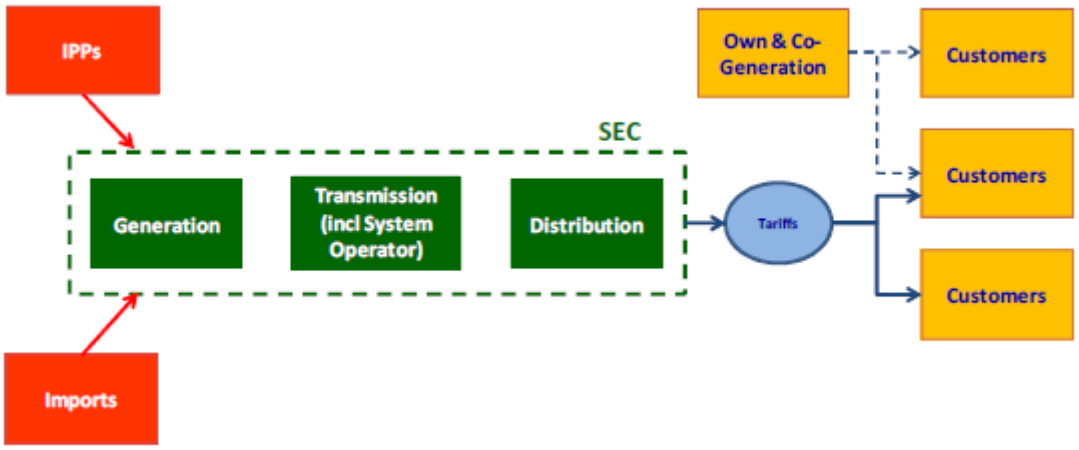
YEARS	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Demand (MW)	223.6	225.8	228.1	230.3	232.6	235	237.3	239.7	242.1	244.5	245

Source: SEC Generation Expansion Plan, 2014

Table 2.1: SEC System Peak Demand Forecast in MW

While electricity supply is one of the most important themes within Swaziland's energy sector, supply constraints and rising costs pose many challenges for the electricity industry (MNRE,

2009). The Swaziland Electricity Company's Annual Report 2013/14 indicates that, of the 1 212.6 GWh distributed during the year, only 347.1 GWh was produced locally. This attributes only 28.6 % to local generation, with the rest imported from South Africa's Eskom (61.1%), Mozambique's EDM (8.5%), and the South African Power Pool's DAM (1.7%). Although Swaziland's membership to the Southern African Power Pool (SAPP) enables the SEC to freely purchase electricity from other members within the power pool, the sharply rising costs of electricity from South Africa's Eskom (the largest exporter in the region) is heavily challenging the company's mandate of supplying affordable electricity. Before the introduction of the Energy Regulatory Authority Act of 2007, the SEC used to set the electricity tariffs. However, since then, electricity prices are regulated by the Swaziland Energy Regulatory Authority (SERA). Figure 2.2 illustrates Swaziland's Electricity Market Structure.



Source: SERA Electricity Tariff Methodology, 2011

Figure 2.2: Swaziland Electricity Market

In recognition of the challenges posed by supply constraints and raising costs, Swaziland has undertaken some reform in the energy sector – in an endeavour to attract private investment in power generation (SERA, 2011), address inefficiencies in the industry, and ensure reliability, quality, and affordability of electricity supply to customers (MNRE, 2009). These reforms included the amendment of the Electricity Act of 1963, and the formulation of the Swaziland Electricity Company Act of 2007 and the Energy Regulatory Act of the same year. Following the implementation of the reforms, Swaziland set several short-term targets to ensure that the challenges identified would be addressed. The establishment of performance indicators and the implementation of prepaid metering were identified to address inefficiencies, while the assessment of local generation options and feasibility studies thereof, were given firm

deadlines. Although progress has been slow in some areas, most of these targets have been attained or at an advanced stage.

Furthermore, the SEC has developed a Generation Expansion Plan to "ensure development of generation plants in Swaziland to cater for the growing demand for electrical energy" (SEC, 2014). According to this plan, a majority of the proposed potential generation plants are driven by Independent Power Producers (IPPs). Mkhonta (2015) contends, however, that the development of IPPs in Swaziland has been hindered by the lack of an energy policy framework and a national grid code. Partly due to this reason, addressing the electricity generation infrastructure gap has been further delayed, thus impeding the country's economic growth. As illustrated in the SEC's Generation Expansion Plan, generation capacity is projected to only satisfy demand in year 2022 – assuming financing for new generation plants is available, and current generation plants are still in commission.

2.7. Summary

The several studies carried out to investigate the relationship between infrastructure and economic growth have mostly found that a strong link exists between the two. In fact, more than half of Sub Saharan Africa's positive growth since year 2000 can be attributed to infrastructure. Although empirical research investigating the effect of infrastructure on economic growth has usually faced the challenge of reverse causality, it has been established that a one way causality exists from infrastructure to growth. Also, power infrastructure has been found to have a greater impact on GDP growth, yet the largest infrastructure deficit lies in the power sector.

The macro-economic environment, quality of governance, and government financial capacity are found to have strong influence on the level of infrastructure finance. Well-functioning credit and capital markets are also necessary to improve investment through enabling innovative finance mechanisms, such as Private-Public Partnerships (PPPs) and Diaspora Bonds. PPPs are found to currently be the most popular type of alternative finance for infrastructure. Swaziland has exploited this mechanism through the engagement of Independent Power Producers, and the government has shown some support by introducing some reforms the electricity industry to improve transparency and predictability.

Chapter 3: Data and Methodology

3.1. Introduction

The purpose of this study is to examine the extent of the relationship between the level of electricity infrastructure investment and economic growth in Swaziland. Also, the study aims to quantify the relationship between electricity infrastructure investment and the factors identified by literature to influence such investment. The latter study objective is similarly done within the context of Swaziland's economy.

The core objective of this study is therefore twofold. First, the study seeks to verify what the literature suggests with regards to the relationship between infrastructure investment and economic growth – within the context of electricity infrastructure and Swaziland's economic growth. Secondly, to help the authorities in Swaziland with developing more focused and effective policies for infrastructure development, the study seeks to identify the extent of the influence of certain economic, regulatory, and market factors on the level of electricity infrastructure investment.

This chapter elaborates on the methodology employed to achieve the objectives stated above. The data used in the analysis is first discussed (including any limitations), then followed by a discussion of the variables in the model and methodology.

3.2. Data

In determining the extent to which electricity infrastructure investment is affected by economic and regulatory environment factors, the changes in the addition of electricity infrastructure will be evaluated against several variables that represent the factors expected to influence infrastructure finance. Data indicating the additions of electricity infrastructure is sourced from the Swaziland Electricity Company. Additions to capital assets are manipulated to more accurately represent additions of electricity infrastructure by removing all additions that are not directly related to electricity generation, transmission, or distribution. Economic and monetary policy data, such as GDP growth and inflation rates, was obtained from the World Bank, and the African Development Bank.

Data regarding Financial Market development was sourced from the World Bank's Global Financial Development Database and the Swaziland Stock Exchange. Regulatory Quality data was obtained from the World Bank's Worldwide Governance Indicators, which are aggregate indicators collected over the period 1996 – 2014 that are essentially a summary of the views of businesses and citizens on the quality of governance. Data concerning sources of infrastructure finance – such as Development Aid and Government Revenue was obtained from the World Bank, and the African Development Bank. Details of the data will be further discussed together with the model and methodology employed in next subsection.

The data from the Swaziland Electricity Company was extracted from their audited financial statements. Having been entrusted with the supply of electricity to the Swazi economy since 1963, the SEC is assumed to be a reliable source for data related to the energy sector.

The African Development Bank was established in 1963 with a mandate to promote economic and social development initiatives on the continent. The AfDB believes that critical to achieving their goals is the quality and reliability of data. The Bank is therefore continually improving both the quantity and quality of their data.

The World Bank has been in existence since 1944. Although initially established to aid reconstruction and development post World War 2, the Bank has made sustainability and poverty reduction their main goals. As an important source of financial and technical assistance to many countries globally, the bank has to provide highly reliable data. A challenge faced by the World Bank however, is that data is usually collected by the countries themselves. Nevertheless, the bank does work with the countries to ensure the quality of their statistical systems meets the required quality.

While economic time-series data was relatively easy to find from the reliable sources discussed above, other data proved a challenge to source for the period under review in this study. Because of the relatively under developed financial market in Swaziland, data was not consistently available to indicate the performance of the credit and financial markets over time. Similarly, because of the poorly developed statistical systems in Swaziland, governance and regulatory data has not been consistently recorded to reflect the level of regulatory quality. Furthermore, governance and regulatory environment indicators are relatively new measures

and have not been widely adopted as high priority in developing and poor regions – where poverty reduction and healthcare are seen as top priority.

As a result of the challenges discussed above, the World Governance Indicators' regulatory quality score data sourced from the African Development Bank had some missing observations. To overcome this problem, a linear regression was done to fit a function in the available data (as illustrated in figure 3.1), from which the missing observations were estimated.

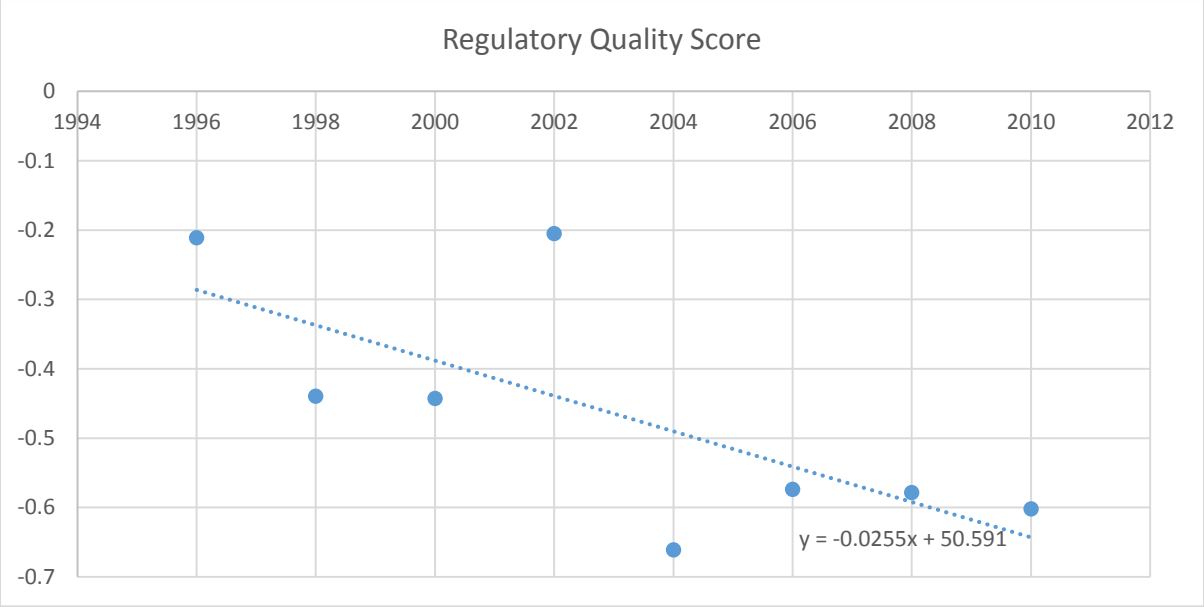


Figure 3.1: Fitted Linear Function on Regulatory Quality Data

A critical shortcoming of the data is that it is limited to 17 annual observations. This is because the Swaziland Electricity Company only had records of electricity infrastructure investment (dependant variable data) from year 1996. This limitation may pose a challenge with regards to the efficiency and accuracy of any regression model we apply in establishing the relationship between our dependant variable and the explanatory variables.

3.3. Methodology

This study uses the lessons learnt through previous research as a solid foundation from which to build a solution that is backed by sound financial principles to contribute towards addressing the investment gap in the electricity sector in Swaziland. This required reviewing the literature on infrastructure finance in developing economies in general, but with a strong focus on regions

and countries with similar characteristics and challenges to those of the Swazi context. The literature review was done to also examine the relationship between infrastructure investment and economic performance, as well as identifying the factors affecting the level of infrastructure investment and how other countries and regions have achieved relative success in addressing some of the constraints that limit the level of investment in infrastructure.

Quantitative methods are used to analyse the extent of the relationship between electricity infrastructure investment and economic growth in the context of Swaziland. This analysis also benefits the study in examining the extent to which the factors that influence infrastructure investment are affecting electricity infrastructure development in Swaziland. Trend analysis is extensively applied to examine the relationships indicated above. Also, a regression model derived from econometric theory is used to estimate the relationship between infrastructure finance and its determining factors. In equation 3.1, the level of electricity infrastructure finance (*INFR*) is measured using the annual value of electricity infrastructure projects, while the explanatory variables represent those economic, regulatory, and financial market factors that influence infrastructure investment.

$$INFR = \beta_0 + \beta_1 GDPG_G + \beta_2 \Delta IFR + \beta_3 REV + \beta_4 CRED + \beta_5 CAP + \beta_6 REG + \beta_7 RECS + \varepsilon_t$$

(*Equation. 3.1)*

Where:

INFR = Additions to electricity infrastructure (dependant variable)

GDPG = Gross Domestic Product Growth (GDP Growth)

ΔIFR = Annual Change in Inflation Rate

REV = Total Government Revenue (% of GDP)

CRED = Credit to Government and SOE (% of GDP)

CAP = Stock Market Capitalisation (% of GDP)

REG = Regulatory Quality Score

RESC = Dummy variable for Recession period (0 = years outside recession; 1= recession)

β_1 to β_6 = coefficients representing strength of relationship between explanatory variable and dependant variable.

ε_t = the error term, capturing the unobservable factors affecting infrastructure finance

Additions to electricity infrastructure (INFR): This variable represents the annual expenditure on electricity infrastructure, and is therefore the dependant variable in this study. From the data

sourced from the Swaziland Electricity Company, 'additions to capital assets' are manipulated to more accurately represent 'additions to electricity infrastructure' by removing all additions that are not directly related to electricity generation, transmission, or distribution. Consequently, this variable indicates completed capital projects for that period, hence it represents functional infrastructure. `

GDP Growth (GDPG): Although the direction of causality may be open to dispute, the literature suggests a strong relationship between infrastructure and economic growth. Sahoo and Dash (2009) not only agree that a firm relationship exists between economic growth and infrastructure, but they further argue that a one-way causality exists that runs from infrastructure to growth, and find no reverse causality from GDP growth to infrastructure. However, Yu, De Yong, Storm, and Mi (2012), find a unidirectional causality running from economic growth to transport infrastructure in China's underdeveloped regions. They subsequently argue that, in underdeveloped regions, investment in a particular type of infrastructure may not be enough to stimulate economic growth, especially where complementary factors are also underdeveloped. Consequently, the reason for the inclusion of this variable in the analysis is to measure the extent of the relationship between electricity infrastructure investment and economic growth, so as to indicate the extent to which infrastructure investment should be a priority for the economic development of Swaziland. The expectation is that as investment in electricity infrastructure increases, increased economic growth will be effected.

Annual Change in Inflation Rate (Δ*IFR)*: The change in inflation rate is included in the model to indicate macroeconomic stability. A predictable macroeconomic environment allows investors to more confidently make the long term investment decisions necessary for infrastructure finance. Kirkpatrick et al. (2005), in their study of the impact of economic regulation on the inflow of private foreign investment in infrastructure in Asian economies, capture the consistency of monetary policy by including the change in the rate of inflation. They argue that the significance of macroeconomic stability in attracting foreign investment inflows to infrastructure has been much advocated by the literature.

Rogoff and Reihart (2003) suggest that, while strong and stable macroeconomic policies are not sufficient conditions for attracting investment, macroeconomic stability is almost certainly an important component – especially price stability. They further argue that high inflation

drastically increases the risks of doing business. Demirhan and Masca (2008) include inflation in their study of factors that influence foreign direct investment inflows in developing countries. They find inflation, as an indicator of economic stability, to be significant.

Total Government Revenue (REV): This variable has been included to indicate the government's ability to finance infrastructure development because most of the current infrastructure spending in developing economies is financed through domestic budgets. Infrastructure spending tends to increase with an increase in the government's revenue proportion derived from taxes (Arimah, 2005). Although about half of the Swaziland Government's revenue comes from the Southern African Customs Union, rather than domestic taxes, this income is classified as tax. The *Total Government Revenue* does, however, exclude revenue received as grants.

Credit to Government and State-Owned Enterprises (CRED): The argument of the importance of governments' role in financing infrastructure – especially in developing countries – has already been made in the preceding section. However, due to worsening socio-economic conditions, most fiscal budgets are increasingly constrained as citizens have become impatient to a point where they now demand direct financial assistance from governments for health, education, and basic services. Consequently, access to credit has become significant for governments to be able to support expenditure on infrastructure. The Swaziland Electricity Company (a state-owned company) has the responsibility of closing the electricity infrastructure gap such that electricity supply meets current and future demand. The inclusion of the *Credit to Government and State-Owned Enterprises* variable is therefore important for quantifying the extent of its influence to the level of investment in infrastructure.

Stock Market Capitalisation (CAP): This variable is included in the model to represent the level of capital market development as a possible source for supporting investment in infrastructure. Kirkpatrick et al. (2005) contend that underdeveloped financial and capital markets are an obstacle to local financing of large scale private investments – such as infrastructure investments. Khumfula (2005) argues that the poorly organized capital markets of many developing countries, are regarded as ineffective in mobilizing capital for infrastructure investment. The literature suggests that this variable has a positive relationship with infrastructure investment – especially where the role of private investment is increasing. Privatization can be regarded a possible solution to the under-investment in infrastructure by

the public sector, and the access to private capital markets would ease the pressure on the fiscal resources, (Helm, 2009). It is therefore expected that as the stock market capitalisation increases, investment in infrastructure should increase.

Regulatory Quality Score (REG): The regulatory quality score is constructed from several variables that collectively indicate the soundness and effectiveness of the country's policies – especially with regards to the promotion of private sector participation. The quality of the regulatory environment positively influences investors to invest in infrastructure projects in developing countries. This is because the increased predictability created by a conducive regulatory environment reduces risk to the large investments necessary for financing infrastructure. Zhang et al. (2004) argue that higher electricity generation and capacity are correlated with the formation of an independent regulatory body, whose effectiveness is reliant on a conducive regulatory environment. Kirkpatrick et al. (2005) further provide evidence that shows regulatory quality to have a positive influence on foreign direct investment in infrastructure in low and medium countries. The inclusion of this variable in the model is thus to probe the effectiveness of regulatory quality in positively influencing investment in electricity infrastructure in Swaziland. It is expected that as this variable increases, so will investment in electricity infrastructure.

Chapter 4: Data Analysis and Results

4.1. Introduction

In this chapter, the data described in the preceding section is analysed to give more meaning in the context of this study. Time series trends of the variables are examined first to give an overview of the historical behaviours of the factors during the period under review. Background information is given to support the trend behaviour where applicable. A discussion of the descriptive statistics follows thereafter, then a detailed examination of the relationship between electricity infrastructure investment and the rest of the variables is performed through comparative trend analysis. Finally, the OLS regression results are presented and analysed.

4.2. Variable Analysis

4.2.1. Change in Level of Infrastructure Finance

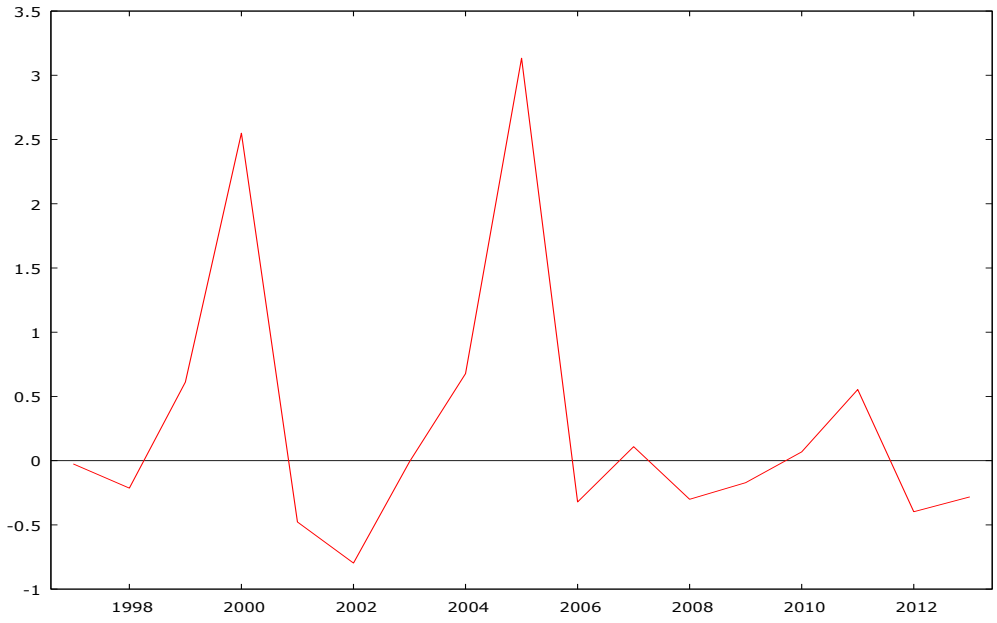


Figure 4.1: Change in Level of Infrastructure Finance

Figure 4.1 illustrates annual change in the level of infrastructure finance. The graph indicates relatively small changes during the period under review, with the exception of years 2000 and 2005. In year 2000, the Swaziland Electricity Company, in an endeavour to improve security of supply, heavily invested in the 400kV integration project. This project was aimed at allowing

the SEC to access the Day Ahead Market through linking its power grid to Montraco's 400kV – which had been primarily constructed to supply power to aluminium smelters in Mozambique. In year 2005, the SEC commissioned the Maguga hydro power project, which increased installed capacity by 19.8 MW.

4.2.2. GDP Growth

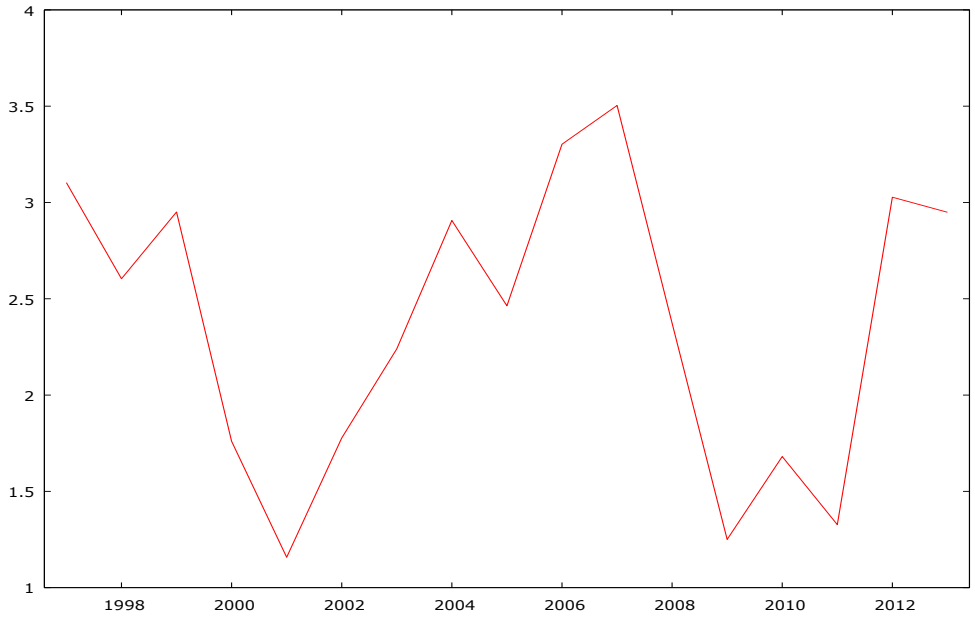


Figure 4.2: GDP Growth

Figure 4.2 depicts clearly how Swaziland has struggled to achieve significant economic growth rates in almost two decades. The sluggishness of the Swazi economy has left it highly sensitive to regional and global economic shocks. This is evident in the time series plot, where significant dips are seen around the two periods of global economic recessions of years 2001 and 2009. The reduction of SACU receipts in 2010 – which government revenue is heavily reliant on – extended the effects of the recession for at least a further year.

4.2.3. Change in Inflation Rate

As part of the Common Monetary Area (CMA), Swaziland's monetary policy is largely linked to that of South Africa and therefore Swaziland's inflation tends to mirror that of South Africa. After the South African Reserve Bank had introduced the inflation targeting framework in February 2000, figure 4.3 shows evidence of volatility in the inflation rate – as indicated by the

sharp changes in the inflation rate up to year 2003. As the framework settled however, the volatility subsided and some stability was realized to a point where Swaziland's inflation rate has not reached double digits since 2009.

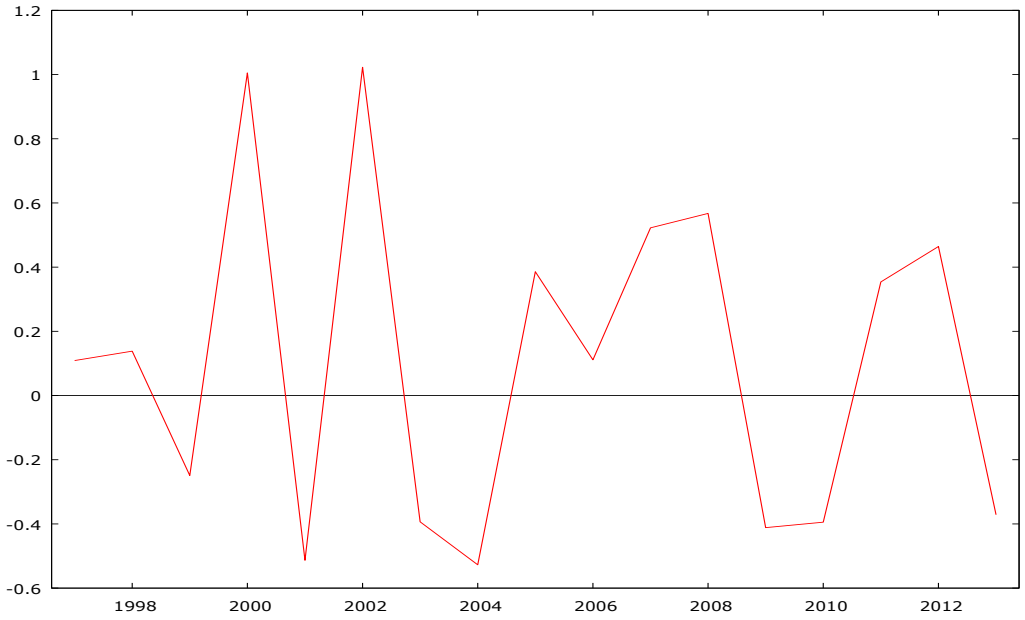


Figure 4.3: Change in Inflation Rate

4.2.4. Stock Market Capitalization

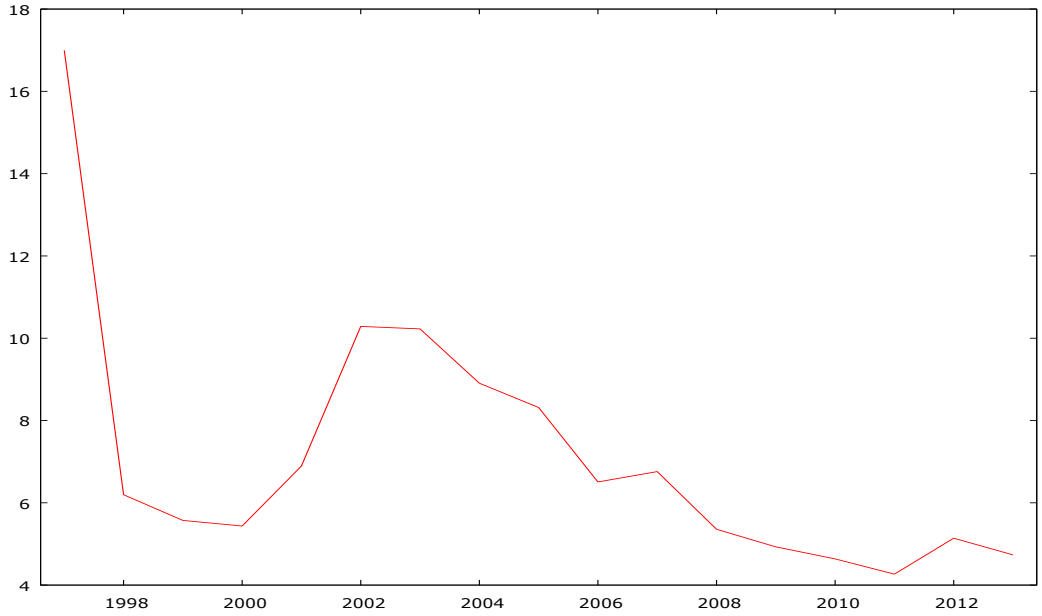


Figure 4.4: Stock Market Capitalisation

The Swaziland Stock Exchange began operating in 1990 essentially as an over-the-counter single stockbroker facility working under the Central Bank of Swaziland. In 1999, the Swaziland Stock Exchange (SSX) was officially launched with the principal functions of providing primary and secondary markets for raising capital and trading securities respectively. However, since its launch, the SSX has not achieved the desired growth in terms of market capitalisation. As illustrated in figure 4.4, market capitalization (relative to GPD) has decreased since 1999. The increase between years 2000 and 2002 is more a reflection of the reduction of the economy (in terms of GDP), than an increase in market capitalisation. Between years 2000 and 2014, there has been only two new listings, and two de-listings on the SSX, and the total number of listings has essentially remained at six during this period.

4.2.5. Regulatory Quality Score



Figure 4.5: Regulatory Quality Score

The Government of Swaziland's effectiveness at creating an environment conducive to foreign investment and private sector development, through sound regulation, has generally been considered subpar. With a range of -2.5 (weak regulatory performance) to +2.5 (strong regulatory performance), Swaziland has achieved a highest regulatory quality score of only -0.21 since 1996, and has remained below the 45 percentile rank among all the countries on the Worldwide Governance Indicators' Regulatory Quality Score over at least the last 15 years.

Between 1996 and 2007, the regulatory quality has been depicted by a downward trend because of the lack of effective policies and regulation to support the business environment.

Since the mid-2000s however, the Government of Swaziland has made a concerted effort to improve the regulatory environment. This has resulted in the introduction of regulatory bodies in several sectors of the economy, including energy, financial, and construction – which have also been backed by relevant legislation. The Swaziland Energy Regulatory Authority was introduced in 2007, while the Financial Services Regulatory Authority was introduced in 2010. The effect of the government's efforts towards improving regulatory quality and effectiveness is visible in figure 4.5, where the score has trended upwards since 2007.

4.3. Summary Statistics

	INFR	*GDPG*	*REV*	*IFR*	*CRED*	*CAP*	*REG*
Mean	0.2769	2.3752	30.5977	0.1070	2.0572	7.1270	-0.4918
Median	-0.0252	2.4633	31.180	0.1112	2.0810	6.1966	-0.5538
Standard Deviation	1.0471	0.7572	4.6482	0.5130	1.1964	3.1657	0.1408
Kurtosis	3.5876	-1.2662	-0.3892	-0.9862	-0.4022	5.3175	-0.5697
Skewness	1.9956	-0.2808	0.0529	0.3696	0.4798	2.1075	0.4731
Range	3.9306	2.3458	16.30	1.5502	4.0270	12.7317	0.50
Minimum	-0.7971	1.1579	23.110	-0.5274	0.5350	4.2657	-0.7052
Maximum	3.1335	3.5037	39.410	1.0228	4.5620	16.9974	-0.2052

Table 4.1: Descriptive Statistics

The relatively large standard deviation of the electricity infrastructure finance data indicates some inconsistency in the investment levels in such infrastructure in Swaziland. However, if the highly positive skewness of the data is taken into consideration, it becomes evident that the volatility is likely influenced by a few outlying events. As discussed earlier, the 400kV integration project in year 2000, as well as the investment in a 19.8 MW hydro power plant in year 2005, were significantly higher investments than the Swaziland Electricity Company normally spends on infrastructure annually. Those two investments therefore, have had a significant impact on the consistency and distribution of investments during the period under review.

The volatility of the changes in inflation rate can be mostly attributed to the period immediately after the South African Reserve Bank (SARB) introduced the inflation targeting framework in year 2000. This volatility notably decreased once the new policy settled, and the economy then achieved relative stability. Although the inflation rate does not absolutely mirror that of South Africa, Swaziland is part of the Common Monetary Area, and therefore the Central Bank of Swaziland generally follows the SARB's monetary policy. Since 2009, the country's inflation rate has remained below 10 percent.

Activity in the financial markets in Swaziland has remained relatively subdued in the last 15 years. With only two new listings on the Swaziland Stock Exchange over this period, the market capitalization has remained relatively low. The positive skewness of the market capitalization per GDP data indicates that the mean has been significantly influenced by outlying observations. The higher magnitude of these observations can be attributed to a reduction in GDP, rather than a significant increase in the market capitalization itself.

	INFR	*GDPG*	*REV*	*IFR*	*CRED*	*CAP*	*REG*
INFR	1						
GDPG	-0.0488	1					
REV	-0.1422	0.3401	1				
IFR	0.2524	0.0510	0.0933	1			
CRED	-0.1875	0.0812	-0.2195	-0.0820	1		
CAP	-0.0385	0.2524	0.0496	0.0331	-0.1970	1	
REG	-0.2045	-0.0850	0.0549	0.0869	-0.1730	0.4708	1

Table 4.2: Correlation Matrix (5% critical value (two-tailed) = 0.4821)

Table 4.2 illustrates the correlation between the variables in this study. The highest correlation is between regulatory quality and market capitalization per GDP. It is expected that as the quality of regulation in an economy improves, investors' confidence in the markets improve, and they are therefore more comfortable with investing in the capital market. The correlation between GDP growth and Government revenue is also significant. As an economy's output increases, it is anticipated that revenue to the government will increase through higher tax revenue.

4.4. Data Analysis

4.4.1. Trend Analysis

Although there might be some argument on the direction of causality between infrastructure investment and economic growth, the literature generally agrees that there is a strong positive relationship between the two. A comparison of the electricity infrastructure investment and economic growth data trends in Swaziland is illustrated in figure 4.6, where the trends are plotted on the same plane.

Initially, from 1997 to 1999, there is some positive correlation between the two variables. This relationship is broken in year 2000 where investment in infrastructure sharply increases, while GDP growth firmly moves the opposite direction. The sharp increase, however, is as a result of an outlier event that actually lies outside two standard deviations from the mean. This observation reflects the relatively large investment made by the SEC towards the integration of its national grid to the 400kV network. In fact, during year 2000, the 400kV integration project was responsible for 79 percent of the total infrastructure expenditure. Removing this project from the data would actually result in the positive correlation between electricity infrastructure investment and GDP growth being extended by a further 5 years to 2004.

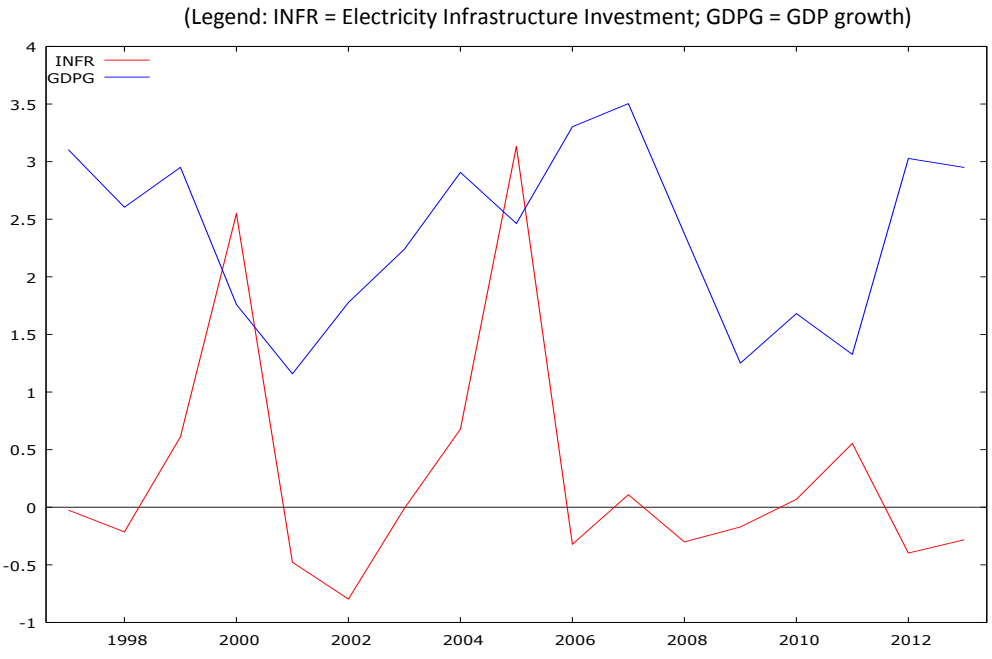


Figure 4.6: Electricity Infrastructure Investment vs GDP Growth

Similarly, the positive relationship between the variables is broken by another sharp increase in electricity infrastructure spending in year 2005. Again, this increase can be attributed to a single relatively large investment project. In year 2005, the SEC spent 59 percent of its electricity infrastructure budget on the construction of a 19.8 MW hydro power station. Adjusting the data, by omitting the investment in the hydro power plant would have maintained the positive correlation between electricity infrastructure investment and GDP growth up to year 2008. From 2009 to 2013, the relationship between the two variables shifts from positive to negative correlation, which is contrary to the literature. This period was, nevertheless, a rather abnormal period, where the global economy was in one of the worst recessions since the great depression of the 1930s.

While initial analysis of the trends in figure 4.6 suggests a very weak relationship between electricity infrastructure investment and GDP growth, further analysis makes a strong argument for a mostly positive relationship between the two variables. This is in agreement with the findings of the literature – that infrastructure and economic growth are positively correlated.

Figure 4.7 is a comparison of electricity infrastructure investment and government revenue data trends for the period under review. This comparison reveals almost no correlation between the two variables, even if the two infrastructure investment events already presented as outliers are adjusted for.

Further analysis of the trends may suggest that the investment in the hydro power plant by the SEC in 2005 effected an increase in revenue for the government of Swaziland, as illustrated by the strong upward trend in revenue between 2006 and 2007. Because the SEC is 100 percent owned by the government, it can be expected that an increase in the company's revenue, as a result of the investment in the power plant, would have a significant positive impact on the government's revenue.

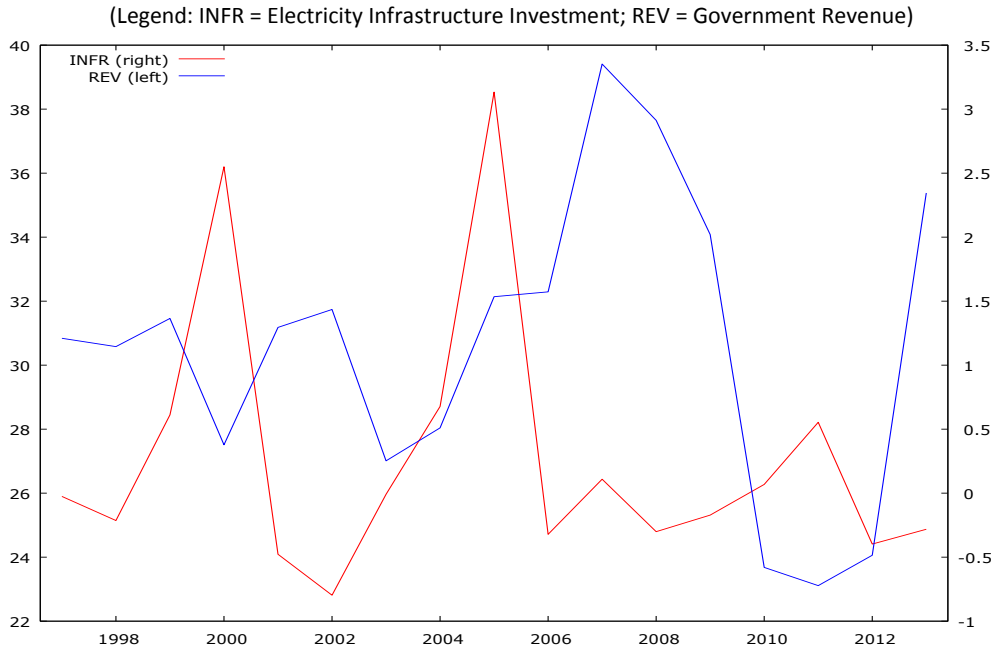


Figure 4.7: Electricity Infrastructure Investment vs Government Revenue

However, because Swaziland's revenue is so heavily dependent on the Southern African Customs Union (SACU) revenues (about 50 percent of total revenue is SACU receipts), the sharp increase in 2006/2007 in more a result of an increase of SACU receipts than a result of income from the investment in the power plant. Between 2006 and 2008, SACU receipts to Swaziland increased by more than 70 percent, which was then followed by a sharp decline up to 2010, following the global recession. As illustrated in figure 4.7, the government revenue trend is strongly influenced by the SACU revenue changes described.

It can be deduced therefore, that there is no correlation between electricity infrastructure investment and government revenue between years 2006 and 2013. This is also true for the period before 2006, even if the two relatively large investments of 2000 and 2005 are removed to 'smooth out' the trend. Consequently, it can be concluded that in the case of Swaziland, the government's role in funding electricity infrastructure investments is not principally influenced by its financial ability to invest in such infrastructure.

An analysis of figure 4.8 reveals a generally positive relationship between electricity infrastructure investment and the change in inflation rate. The change in inflation rate variable is an indication of the effectiveness of monetary policy in maintaining a stable macroeconomic environment. The period between 2001 and 2004, where there seems to be negative correlation between electricity infrastructure investment and changes in inflation rate, was a period where

macroeconomic stability was generally low. This was while the inflation targeting monetary policy framework was settling in, following its adoption by the SARB in 2000.

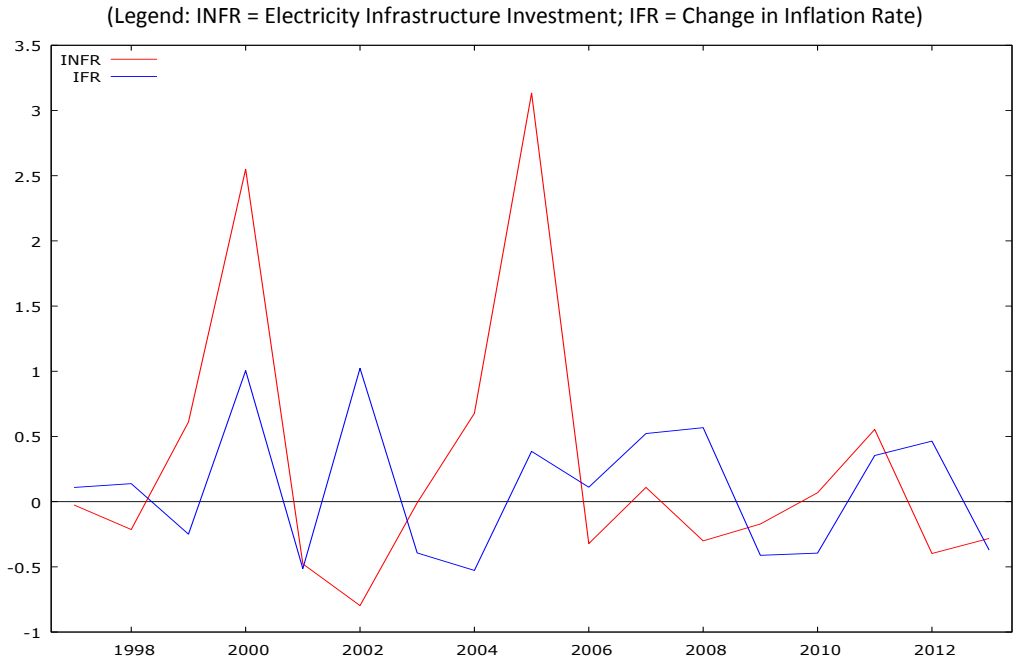


Figure 4.8: Electricity Infrastructure Investment vs Change in Inflation Rate

Because the majority of the resources necessary for electricity infrastructure projects are imported, the stability of the economy becomes even more important in the decision making process, whether by domestic or foreign investors. For foreign investors, the investment decision is further complicated by the fact that the cash flows from the investment are then heavily impacted by foreign exchange rate volatility. It can be further argued that, due to the large capital necessary for such projects, even domestic investors can be extensively exposed to foreign exchange rate volatility, because large capital is mainly sourced externally.

Based on the comparative trend analysis, and a positive correlation coefficient of 0.25, it can be concluded that the stability of the macroeconomic environment is an important influential factor towards fostering investment in electricity infrastructure in Swaziland. Along with a vast amount of literature on infrastructure finance, Rogoff and Reihart (2003) agree that, while strong and stable macroeconomic policies are not sufficient conditions for attracting investment, macroeconomic stability is almost certainly an important component – especially price stability. Consequently, it is imperative that an effective monetary policy framework be maintained if investment in electricity infrastructure is to be attracted to such an extent that the infrastructure shortfall is overcome.

As alluded to previously, the stock market in Swaziland hasn't been effective in providing access to large amounts of capital at low cost. Figure 4.9 illustrates the market capitalization of the Swaziland Stock Exchange against electricity infrastructure investment. An indication of the challenges the capital market has faced, is the downward trend of the market capitalization relative to GDP over the decade preceding 2014.

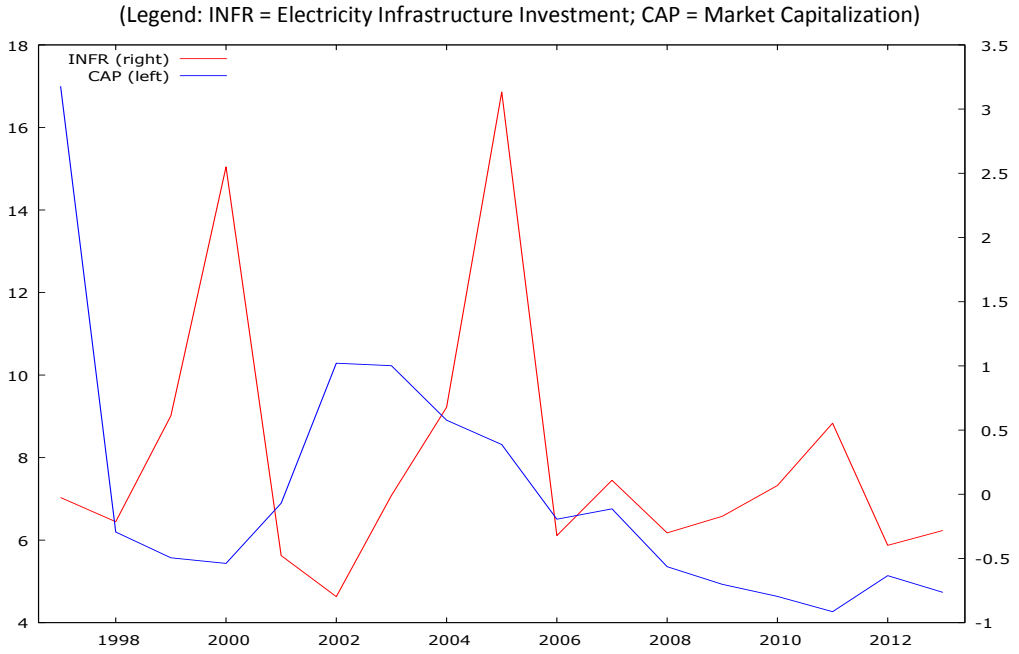


Figure 4.9: Electricity Infrastructure Investment vs Market Capitalization

Analysis of the trends in Figure 4.9 reveals a weak relationship between the two variables. The dominant challenges of the stock market are the lack of liquidity and its small size, which translates to an inefficient stock market. Also, although the establishment of the stock market had initially been envisaged to benefit the parastatals with regards to raising capital, there seems to have been some resistance from the government to give up any ownership of these companies.

Because the bond market has suffered similar fate to that of the stock market, it can thus be concluded that the financial markets have not been a factor towards influencing the level of electricity infrastructure finance in Swaziland.

Zhang at al. (2004) highlight a conducive regulatory environment as being correlated to higher electricity generation and capacity. Figure 4.10 illustrates Swaziland's regulatory quality trend

compared against the level of electricity infrastructure finance. This comparison reveals essentially no correlation between the two variables over the period under review, clearly in contradiction with the literature. The regulatory quality in Swaziland has generally been below par in recent history, but due to some focused effort from the mid-2000s by the government, the regulatory environment has seen some improvement over the years subsequent to 2010.

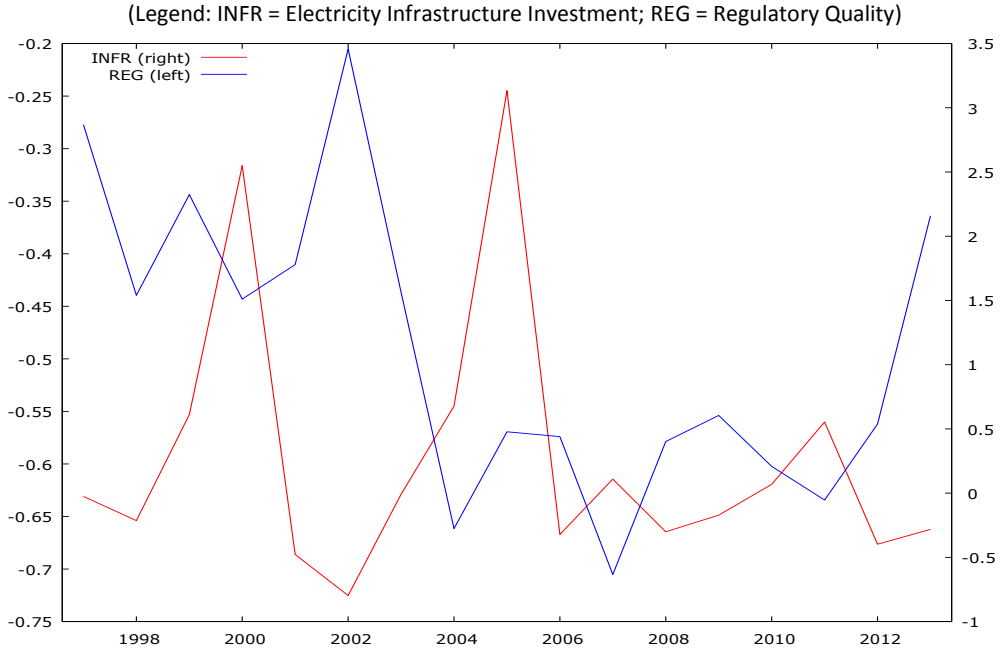


Figure 4.10: Electricity Infrastructure Investment vs Regulatory Quality

The negative correlation observed between electricity infrastructure finance and regulatory quality is contrary to the literature. This can be attributed to the fact that, either than by the SEC, there has essentially been negligible contribution to Swaziland's electricity infrastructure by any other investor. Because electricity is the company's sole business, and the fact that it is a parastatal, the SEC has therefore had little choice – regardless of the regulatory quality – than to provide electricity as required, as far as its resources allowed.

As can be seen in figure 4.10, regulatory quality was essentially on a downward trend up to year 2007. From 2010, however, a steep improvement can be observed, as a result of the introduction of several regulatory bodies that were backed by relevant legislation. This has allowed other players, besides the SEC, to enter the electricity market and thus enabling future investment in infrastructure from both domestic and foreign private investors. Consequently, although the results of this study reveal negative correlation between regulatory quality and

electricity infrastructure investment, it is likely that as the openness of the market improves, the relationship between the regulatory quality and investment will become positive.

Figure 4.11 illustrates a comparison of electricity infrastructure investment and credit extended to the government and parastatals. The Swaziland Electricity Company, which has been mainly responsible for electricity infrastructure investment thus far, is a parastatal wholly owned by the government. Because of the relatively large capital necessary for infrastructure projects, credit is necessary to finance such projects. Nevertheless, an analysis of the trends in figure 4.11 indicates almost no patterns that illustrate any relationship between the level of credit extended to the government and parastatals, and the level of electricity infrastructure finance. This finding is contrary to the expectation, based on the literature.

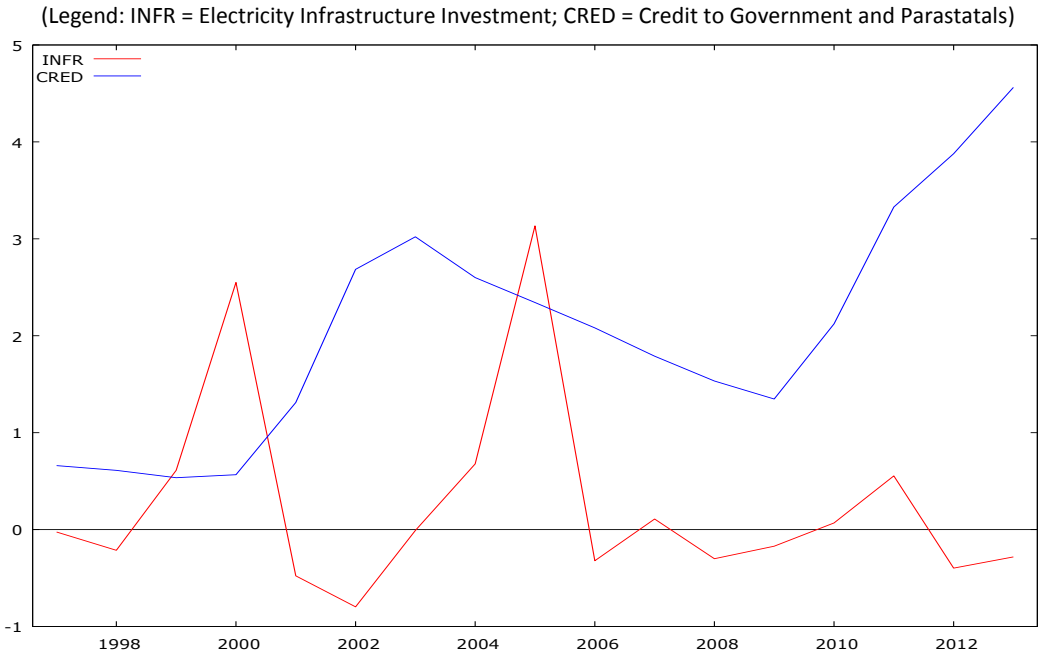


Figure 4.11: Electricity Infrastructure Investment vs Credit to Government and Parastatals

The lack of correlation between these two variables does, however, somewhat support the earlier finding that the level of government revenue had little effect towards the level of electricity infrastructure investment. If the availability of financial resources does not significantly influence the government's decision to invest in electricity infrastructure, then it is reasonable to expect that any credit extended to the government would have little bearing on the level of electricity infrastructure investment. Even so, it is important to note that the data used in this analysis includes credit extended to the government and all parastatals in Swaziland, including the telecommunications company – where investment has generally been

high in the last decade due to the fast-paced development of the sector. As a result, the credit extended to the SEC for investment in electricity infrastructure might be a relatively low percentage of the total amount.

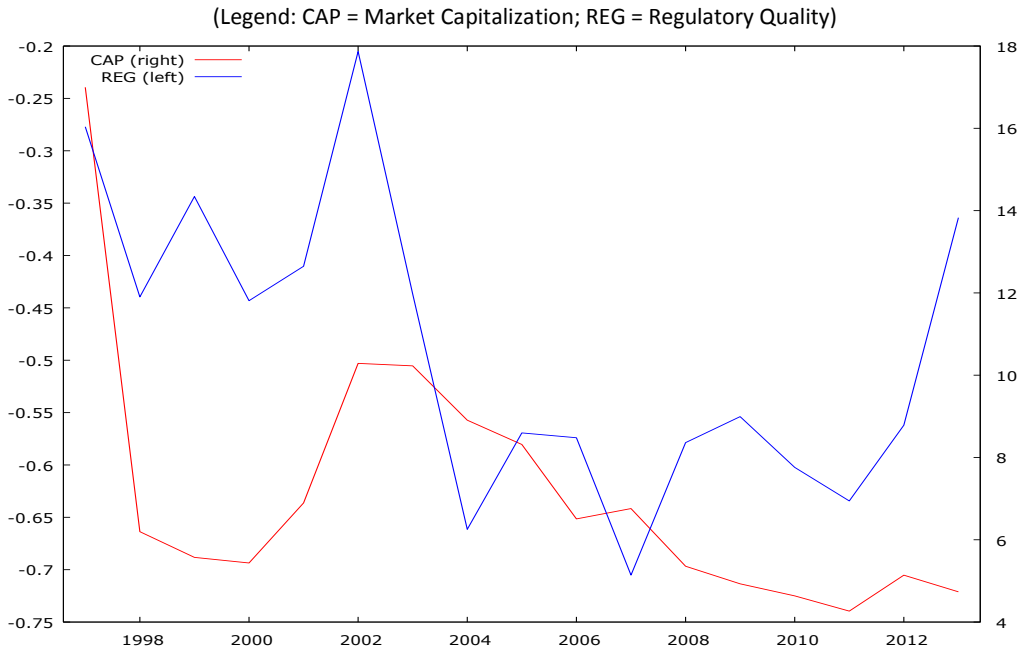


Figure 4.12: Market Capitalization vs Regulatory Quality

An interesting observation from the data analysis is the strong, and positive, correlation of 0.47 between regulatory quality and market capitalization. This correlation is also illustrated in figure 4.12 – if the volatility of the regulatory quality is ignored. Therefore, if the quality of the regulatory environment maintains its upward trend, the capital market will also become more efficient because of higher market capitalization and consequently increased liquidity.

4.4.2. OLS Results

Due to the low number of observations, the OLS regression is not expected to yield results that can be considered reliable in isolation. The OLS regression is however applied here to support and verify the results of the trend analysis used extensively in the study.

Table 4.3 presents the results of the OLS regression ran on the data without including the dummy variable for recession periods. The results of the regression reveal a vague relationship between the dependent variable and any of the explanatory variables. None of the explanatory

variables are statistically significant at the conventional 1, 5, or the 10 percent significance levels, even though the potential weakness of autocorrelation had been controlled for.

OLS, using observations 1997-2013 (T = 17)
Dependent variable: INFR
HAC standard errors, bandwidth 1 (Bartlett kernel)

Variables	***Coefficient***	***Std. Error***	***t-ratio***	***p-value***
const	0.958864	2.45734	0.3902	0.70457
GDPG	−0.0127066	0.249726	-0.0509	0.96042
REV	−0.046443	0.0545725	-0.8510	0.41466
IFR	0.560751	0.44125	1.2708	0.23256
CRED	−0.217818	0.190565	-1.1430	0.27966
CAP	0.0164721	0.0825567	0.1995	0.84585
REG	−2.11451	1.94424	-1.0876	0.30230

Mean dependent var	0.276894	S.D. dependent var	1.047085
Sum squared resid	13.99864	S.E. of regression	1.183159
R-squared	0.202001	Adjusted R-squared	-0.276798
F(6, 10)	0.710277	P-value(F)	0.649747
Log-likelihood	−22.47081	Akaike criterion	58.94161
Schwarz criterion	64.77411	Hannan-Quinn	59.52137
rho	0.011645	Durbin-Watson	1.926458

Table 4.3: OLS Regression Results (without controlling for Recession periods)

However, as illustrated in the regression results in table 4.4, with the introduction of the dummy variable for recession periods, GDP growth and Inflation rate are both statistically significant at the 5 percent significance level.

Contrary to the literature, the coefficient for GDP growth is negative. Again, this result is likely due to the significant investments characterised as outlier events in the trend analysis. Also, as described earlier, a limitation of the data is the low number of observations due to the limited information from the electricity infrastructure investment data source. This limitation, makes the OLS regression vulnerable to the volatility in the data, and thus inefficient.

Model 2: OLS, using observations 1997-2013 (T = 17)
Dependent variable: INFR
HAC standard errors, bandwidth 1 (Bartlett kernel)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	−0.492382	2.22184	-0.2216	0.82956	
GDPG	−1.1552	0.452952	-2.5504	0.03117	**
REV	0.105104	0.0615351	1.7080	0.12181	
IFR	0.649732	0.220807	2.9425	0.01642	**
CRED	−0.141181	0.130949	-1.0781	0.30902	
CAP	0.0506908	0.0723998	0.7002	0.50153	
REG	−1.49277	1.63651	-0.9122	0.38546	
RECS	−2.45388	0.732571	-3.3497	0.00853	***

Mean dependent var	0.276894	S.D. dependent var	1.047085
Sum squared resid	8.430677	S.E. of regression	0.967854
R-squared	0.519406	Adjusted R-squared	0.145610
F(7, 9)	2.914789	P-value(F)	0.068936
Log-likelihood	−18.16060	Akaike criterion	52.32119
Schwarz criterion	58.98690	Hannan-Quinn	52.98378
rho	0.182034	Durbin-Watson	1.612680

Table 4.4: OLS Regression Results (with control variable for Recession periods)

Nonetheless, the positive coefficient for 'Change in Inflation rate' is in agreement with the literature, the correlation coefficient, as well as the results of the comparative trend analysis – strongly illustrating the importance of a stable macroeconomic environment in attracting investment in electricity infrastructure finance. Because of the data drawback indicated above however, caution is exercised in drawing conclusions from the OLS regression results.

Chapter 5: Conclusion & Recommendations

5.1. Conclusion

Infrastructure is generally regarded as a prerequisite to investment and thus economic growth. Although empirical research investigating the effect of infrastructure on economic growth has usually been contentious with regards to the direction of causality, Sahoo and Dash (2009) find that a one-way causality exists that runs from infrastructure to growth, and find no reverse causality from GDP growth to infrastructure. In agreement with the literature, electricity infrastructure investment is found to be positively correlated to economic growth. For Swaziland to get out of its low economic growth trap, it is therefore important to find ways to increase investment in electricity infrastructure. Electricity demand is already over 260 percent more than generation capacity, and although this deficit is currently supplied through imports, this is clearly an obstacle to economic development, especially because security of supply cannot be guaranteed. This reduces the predictability of the business environment, which is a disincentive to investors.

Although the expectation is that there is some positive correlation between electricity infrastructure investment and government revenue, it was found that there was effectively no correlation between these two variables. Because government revenue is highly constrained by the socio-economic challenges that are prevalent in Swaziland, the development of infrastructure that can receive income from user fees, is almost left entirely to the relevant parastatal. There would therefore be little or no correlation between government revenue and the level of infrastructure investment, as if was found. An extension of this finding, is that it was also established that there is no correlation between electricity infrastructure investment, and credit to government and parastatals. Because the level of the government's financial resources does not translate into investment in electricity infrastructure, it is then reasonable to expect that any credit extended to the government would have little bearing on the level of electricity infrastructure investment.

Swaziland's investment in electricity infrastructure is strongly influenced by the level of macro-economic stability. This is evidenced by the positive correlation found between the electricity infrastructure investment variable, and the changes in inflation rate variable. Because of the large size and long-term nature of infrastructure investments, investors need to

be able to predict mid to long-term economic conditions to be able to make informed decisions that will not pose excessive risks to their ability to get returns on their investments. It is therefore important that policies, especially monetary policy, are in place and well implemented such that a stable and predictable macro-economic environment is maintained.

The capital market in Swaziland has generally struggled to achieve its objectives. The stock market is inefficient because of poor liquidity and the sheer smallness of the stock exchange. Market capitalization has been on a downward trend, relative to GDP, over the decade preceding 2014. Because of these challenges, electricity infrastructure investment has not benefited from the capital markets. As a result, there was no correlation established between market capitalization and the level of electricity infrastructure investment. Further contributing to the ineffectiveness of the capital market towards infrastructure finance, is the reluctance of government to give up any ownership of the parastatals.

Regulatory quality was found to have little correlation to electricity infrastructure investment. However, although the regulatory quality in Swaziland has generally been low, the implementation of reforms by the government to improve regulation in certain sectors of the economy has placed the regulatory quality index on an upward trend. The introduction of the energy and financial sector regulators has brought some consistency and predictability, which has already seen an improved willingness to invest in the Swazi economy.

5.2. Recommendations

Considering that Swaziland has struggled to achieve an economic growth above 2.5 percent since 1992, any avenue likely to break this low-growth trap should be robustly pursued. The development of electricity infrastructure is one such avenue that should be strongly pursued because of its positive effect on economic growth. While infrastructure deficit is not the only hindrance to healthy economic growth, the results of this study agree with the literature in that such infrastructure has strong positive influence on economic growth. Achieving and sustaining a healthy level of economic growth will also address a number of other challenges, including socio-economic challenges – such as poverty. Reducing the electricity infrastructure deficit should therefore be placed very high on the priorities list. However, the importance of maintaining existing infrastructure is also underlined by the literature. The high cost of failures

and repairs in the long term, mean that poorly maintained infrastructure ultimately has a negative effect on the economy.

The finding of a lack of correlation between government revenue and electricity infrastructure finance was found to be very concerning, considering the importance of such infrastructure to the economic performance of Swaziland. This suggests that revenue is likely channelled towards addressing the symptoms of poor economic performance, rather that the causes. The over 22 year sustained low economic growth, is likely a consequence of this short coming. However, because the commitments of government revenue would be very difficult to undo, it is therefore necessary that other sources of finance be urgently pursued to increase investment in electricity infrastructure. Innovative finance mechanisms such as infrastructure bonds, private-public partnerships, and diaspora bonds would ease the burden on the government to finance infrastructure, and thus fast-track the reduction of the deficit.

Although innovative forms of infrastructure finance have great potential, it is nevertheless important that due-diligence be applied in determining where and when these methods should be used, selecting the appropriate finance mechanism, as well as determining the feasibility of these alternatives. The most popular alternative infrastructure finance method in developing countries is private-public partnerships because they are relatively easier to understand and implement. Another reason for this preference is the poorly developed financial markets in developing countries, hence making it difficult to facilitate such transactions. However, in pursuing private-public partnerships, the profit-oriented nature of the private sector should be guarded against in ensuring that infrastructure ultimately serves its purpose to the economy.

Creating a conducive environment for investment is an important factor in addressing the electricity infrastructure finance gap. Policies should be in place that create and maintain a stable macro-economic environment. Besides the stability of macro-economic factors, it is also imperative that regulations governing financial and energy sectors are predictable such that investors are able to make informed long-term decisions. With regards to private-public partnerships, feed-in tariffs bring predictability and the long-term security necessary to allow electricity infrastructure investments to be of lower risk, thus allowing potential investors to confidently invest the large amounts of resources required to develop infrastructure.

It is encouraging to see the effectiveness of the regulatory reforms introduced in Swaziland since the mid-2000s. The regulatory quality index has been on an upward trend since 2010. The study found that a strong positive relationship exists between regulatory quality and market capitalization. Consequently, the improvement of the regulatory environment will also result in the acceptance of diaspora and infrastructure bonds as alternative finance mechanisms for electricity infrastructure development.

Considering that the availability and consistency of data was a significant challenge for this study, there is thus an opportunity for further research in this area as the availability and quality of data improves. As the value of relatively new performance measures, such as governance and regulatory environment indicators, is realised, data availability from reliable sources will also become more consistent. This will allow future studies to apply more robust research methodologies that will yield more reliable results from which more accurate conclusions can be drawn to influence policy in the right direction.

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