



**THE RELATIONSHIP BETWEEN GOVERNMENT DEBT AND
STATE-OWNED ENTERPRISES: AN EMPIRICAL ANALYSIS
OF ESKOM**

by

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DECLARATION

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I declare that "***The Relationship Between Government Debt and State-Owned Enterprises: An Empirical Analysis Of Eskom***" is my own work and that all the sources that I have used or quoted from have been indicated and acknowledged by means of complete references.



SIGNATURE

(Ms Lerato Nkosi)

2019/07/10

DATE

DEDICATION

I dedicate this dissertation to my husband, Themba Nkosi, and my daughter, Ndaloyenkosi Nkosi.

ACKNOWLEDGEMENTS

Firstly, I would like to acknowledge Jesus Christ for the strength He gave me during this time. His Holy Spirit was the one who guided me, taught me and gave me endurance until the end.

To my amazing husband, Themba Nkosi, your patience and understanding has been truly remarkable throughout this journey and I thank you for your unwavering support. To my precious daughter, Ndaloyenkosi Nkosi, thank you for being so well behaved and giving Mommy all this time to study.

To my grandmother, Hlobo, you have been exceedingly supportive, patient and always there to listen when I needed encouragement.

I am grateful to everyone who contributed to the success of this study.

ABSTRACT

While state-owned enterprises play an instrumental role in economic development, they are a significant fiscal risk to the state. This occurs through state-guaranteed loans that have more lax credit monitoring, and soft budget constraints, where state-owned enterprises can increase their debt levels without fear of liquidation or bankruptcy. This study empirically investigated the relationship between Eskom's financial performance and its own debt and government debt, using the utility's financial statements and government debt data from 1985 to 2017. The study used two models, namely, the Vector Autoregression (VAR) Model and the Error Correction Model (ECM) to analyse the data. In terms of the VAR, according to the impulse response functions, a one standard deviation shock to the debt-to-GDP ratio has a minimal impact on the electricity price, Eskom's revenue and Eskom debt. Therefore, an innovation to the debt-toGDP ratio explains a large proportion of itself, as one standard deviation shock to the electricity price has a positive response from Eskom's revenue and its debt. Similarly, a one standard deviation shock to Eskom's revenue has a positive response from the electricity price and Eskom's debt, and a one standard deviation shock to Eskom's debt has a positive response from the electricity price and Eskom's revenue. The forecast error variance decomposition analysis shows that up to 9,17% of the forecast error variance of the debt-to-GDP ratio is explained by the electricity price. Government debt relative to GDP explains 32,9% of the forecast error variance in the electricity price. The electricity price explains 29,51% of the forecast error variance in Eskom's revenue. The forecast error variance for Eskom debt is explained by government debt/GDP which is up to 30,34%. The ECM shows that a long run relationship exists between Eskom's debt relative to government debt, Eskom's revenue relative to the electricity price and Eskom's staff numbers. The study shows that Eskom's increase in revenue is largely attributed to tariff hikes, state-guaranteed loans and equity injections, rather than increases in sales. A large proportion of government debt is comprised of Eskom debt. The proposed avenue as a way forward is partial privatisation or fiscal consolidation.

Keywords:

State-owned Enterprises; Eskom; government debt; VAR; ECM

LIST OF ABBREVIATIONS & ACRONYMS

The following abbreviations or acronyms are used throughout the study:

AD	Aggregate Demand
ADF	Augmented Dickey-Fuller
AR	Autoregressive
AS	Aggregate Supply
DME	Department of Minerals and Energy
DPE	Department of Public Enterprises
DoE	Department of Energy
DW	Durbin-Watson
ECM	Error Correction Model
ED	Eskom Debt
GD	Government Debt
GDP	Gross Domestic Product
INEP	Integrated National Electrification Programme
IPP	Independent Power Producers
IRP	Impulse Response Function
JB	Jarque-Bera
LM	Lagrange Multiplier
NERSA	National Energy Regulator of South Africa
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
P-Value	Probability Value
PFMA	Public Financial Management Act

PP	Phillips-Perron
SARB	South African Reserve Bank
SOE	State-owned Enterprises
VAR	Vector Autoregression

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CHAPTER 1: INTRODUCTION TO THE STUDY

1.1 INTRODUCTION

Keynes (1936) believed that the accumulation of government debt should only be used for public capital expenditure and to stabilise the economy, which is a form of decreasing unemployment. More recently, Tanzi (2016) supported this argument by noting how Keynes proposed that government borrowing should also have a short lifespan, since its primary use is to stabilise the economy in the short term. Therefore, Keynes did not advocate for government debt to be used for government consumption or transfers, whether for social spending or even public entities.

However, Alesina and Tabellini (1990) believe that debt accumulation can serve as a means of redistributing income over time and across generations. They view debt accumulation as a way of reducing the deadweight loss associated with taxes which come from the provision of public goods and services. Barro (1979) developed the Ricardian equivalence hypothesis (REH) to show that expansionary fiscal policy does not have an effect on aggregate demand. His claim was supported by his notion of tax smoothing or constant tax rates. However, this is based on the assumption of a benevolent government that wants to minimise deadweight loss.

Some economists even viewed public spending as a growth factor because they believe large and sustained fiscal injections are justifiable when the growth rate falls below the expected long-term trend. However, Brauning (2005) notes that there is a negative relationship between government debt and economic growth.

The accumulation of government debt is attractive because unlike taxes, it requires little coercion, no administration, and is readily available to repay over an extremely long period of time. However, evidence from Buchanan (2008), Tanzi (2016) and Hyman (2011) suggests that the burden of public debt is shifted to future generations in the form of higher taxes which will be used to pay the interest on the current accumulated debt. This will result in lower living standards for future generations, as much of the income will go towards taxation. In addition, debt financing also causes a decrease in the level of current investment because of higher interest rates on loanable funds once the government has increased its demand for these funds. This

has the capacity to increase unemployment, since the decrease in the volume of investment implies less output and less need for labour (Hyman, 2011).

State-owned enterprises (SOEs) are firms established by government to reach their commercial and political objectives. These firms are usually located in industries such as electricity, infrastructure, banking and water supply. SOEs have a large global footprint and contribute approximately 20% to the global gross domestic product (GDP) (World Bank 2014).

SOEs are also important in providing services to markets in which the private sector would consider it too expensive to invest, or in which the private sector would ultimately overcharge for the respective goods and services (Lipczynski, Wilson & Goddard, 2013:701). In addition, SOEs are the only firms which government can use as the vehicles of its socio-economic and political objectives.

While SOEs play an instrumental role in economic development, they also suffer from several challenges. Their biggest challenge is the fiscal risk that they pose to the government. This occurs mainly through state-guaranteed loans where SOEs are given more lax credit monitoring, face soft budget constraints and are able to increase their debt levels without fear of liquidation or bankruptcy (World Bank, 2014; Xu, 2012: 128). Further challenges SOEs face are deteriorating fixed facilities, poor service quality, chronic revenue shortages, corporate governance, and large outstanding debt levels (Kessides, 2004:2).

1.2 BACKGROUND

South Africa's total government debt in million US Dollars for the period 1985 to 2017 has shown a steep upward trend. For example, government debt that stood at \$148 003 million in 1985, has increased to \$9 428 208 million in 2017. According to the World Bank, South Africa is the most indebted country in Africa (World Bank Statistics, 2018). In 2016, South Africa's external debt data showed that public and publicly guaranteed debt was \$62 195 million.

In recent years, the government's accumulation of debt has been attributed to SOEs. The government has been channelling large amounts of funds to Eskom by mostly guaranteeing their debt. According to the Public Financial Management Act (PFMA) of 1999, one of the functions of the National Treasury is to "promote and enforce

transparency and effective management in respect of revenue, expenditure, assets and liabilities of departments, public entities and constitutional institutions” (PFMA 1999:13). According to the National Treasury’s 2018 Budget Review, SOEs, and in particular, Eskom, account for the majority of government contingent liabilities. Of all public institutions, Eskom accounts for 75% of the guarantees and exposure.

Eskom’s mounting debt levels, fraud, and corruption cases have also resulted in several downgrades from global credit rating agencies such as Moody’s; Standards and Poors (S & P), as well as Fitch Ratings (National Treasury Budget Review, 2018:82). Overall, Eskom’s debt has a significantly negative effect on the country’s fiscus.

1.3 PROBLEM STATEMENT

Eskom’s debt has become an albatross for the national revenue fund because the government has had to guarantee its debt. The extent of the government’s guarantee of its debt is already overstretched, where the utility has borrowed from the state itself, the Development Bank of South Africa (DBSA), African Development Bank of Southern Africa, export credit agencies and the World Bank (DBSA, 2012). This is problematic because on the one hand the entire economy is dependent on Eskom, but on the other hand, the utility has created a pattern of dependency on the state which is widening the government deficit and encourages more borrowing by the government.

According to Hyman (2011), instead of more borrowing, the government can increase taxes, which will, however, be detrimental to citizens’ wellbeing. There is a high probability of this happening, since the state has explored all possible avenues that will give Eskom access to funds, and taxes are also administratively easy to enforce (Black, Calitz & Steenekamp, 2015). Thus far the solution to Eskom’s problems has been to channel more funds into it, which has not been fruitful.

While corporate governance (or the lack thereof) is at the forefront of the financial crises at Eskom, this study seeks to investigate this from an empirical perspective, where the main tool used in the study is Eskom’s financial statements.

1.4 SIGNIFICANCE OF THE STUDY

The significance of this study lies in that it will assist the government to inform policy decisions about the financial and risk management of Eskom as a contingent liability. It is also significant because it can assist the government on the choice of the best strategies to decrease its own debt. Ultimately, this study is important because the appropriate risk management of Eskom is imperative for South Africa's economic growth through the delivery of a consistent supply of electricity. Lastly, the citing of this study can contribute to the dynamic literature on state-owned enterprises and energy, which will advance academic knowledge.

1.5 PURPOSE AND OBJECTIVES

1.5.1 Purpose

The overall purpose of this study is to investigate and understand the impact of Eskom bailouts on government debt. This will be achieved through the objectives, as listed below.

1.5.2 Objectives

The following objectives have been formulated for this study:

1. To determine how the financial performance of Eskom affected government debt in the period from 1985 to 2017.
2. To determine how the financial performance of Eskom affected its own debt in the period from 1985 to 2017.
3. To identify the causes of the crisis at Eskom from a financial perspective.

1.6 HYPOTHESES

According to the literature on SOEs, as well as the National Treasury's Budget Reviews and Eskom's financial statements, a relationship exists between Eskom's financial performance, its own debt, and government debt. As such, the hypothesis is that all the independent variables, namely, revenue, electricity price, staff numbers, the current ratio and debt-to-assets ratio, have a relationship with the two dependent variables, government debt and Eskom debt.

Therefore, the following hypotheses were formulated for this study:

Model 1

H_0 : Eskom's financial performance has no effect on government debt.

H_1 : Eskom's financial performance has an effect on government debt.

Model 2

H_0 : Eskom's financial performance has no effect on Eskom debt.

H_1 : Eskom's financial performance has an effect on Eskom debt.

1.7 METHODOLOGY

This empirical study employed both a Vector Autoregressive (VAR) model and an Error Correction Model (ECM). The application of the VAR was adopted from the work done by Lütkepohl (2006), on the use of impulse response functions and forecast error decomposition analysis.

The ECM was pioneered by Engle and Granger (1981) and is based on the phenomenon of cointegration (Harris 1995; Asteriou & Hall, 2016). Once cointegration is established, the ECM is constructed through various steps which include estimating a long run equation which includes a short run component. Post-diagnostic tests are run to ensure that the model is homoscedastic, contains no serial correlation, is correctly specified, and that its residuals are normally distributed.

1.8 LIMITATIONS OF THE STUDY

This study was conducted with diligence and an aim to be concise and academically defensible. However, any scientific research has a few shortcomings.

- This study collected data from Eskom's financial statements from 1985 to 2017. Prior to 2001, companies had to use the International Accounting Standards (IAS), and afterwards, the International Financial Reporting Standards (IFRS). Therefore, between 1985 and 2000, companies used IAS, and from 2001 to date, companies are using IFRS. As such, there is a difference in the layout of the financial statements between these two periods.

- Eskom was listed in 2005. Prior to 2005, it functioned as a government entity exempt from taxes. This means Eskom's revenue and profits after 2005 are affected by taxes, such as company tax and income tax.
- The study considered using Eskom's working capital as another variable to represent productivity. However, upon the author's calculations, Eskom's working capital was found to be negative.
- The following variables were generated: revenue/price (revenue from price changes); government debt/GDP (debt-to-GDP ratio); Eskom debt/government debt (Eskom debt as a proportion of government debt). The risk of using derived variables is that they may lead to inconsistent results. This is because they have been generated by the author and may result in some differences that deviate from the actual value of the variables.

Even though the study had its limitations, they did not have a significant bearing on the study's theoretical framework or empirical findings.

1.9 ORGANISATION OF STUDY

In order for the purpose and objectives of the study to be achieved, the study was organised in the following way:

Chapter 1: Introduction to the study

This chapter provided a comprehensive introduction, background and problem statement of the study. The chapter introduced the Keynesian theory of government debt as the point departure because it opposes government borrowing to support public entities. SOEs, their advantages, disadvantages and shortcomings were discussed, followed by details of the aims and objectives of the study, the hypothesis, methodology, limitations and the organisation of the study.

Chapter 2: An overview of state-owned enterprises, South African debt, and the Eskom crisis

This chapter gives a thorough account of South Africa's government debt, state-owned enterprises and the Eskom crisis. The chapter presents a broad outline of state-owned enterprises which is followed by a concise discussion of the role of the National Treasury and its duties as guided by the PFMA (1999). It also provides a number of tabular information on the country's public institutions, their guarantees and exposure.

The chronology of Eskom as a company is also given from the 1970s to date. The 1980s' De Villiers commission highlighted the first erroneous state intervention which recommended that Eskom should not charge cost-reflective prices. The rest of the chapter discusses Eskom's building programme, historical average electricity prices, and its balance sheet. The chapter concludes with a discussion of international lessons regarding the power sector.

Chapter 3: Theoretical and empirical literature review

This chapter discusses the theoretical and empirical literature review of the study. It starts by clarifying that the study uses several theories to justify its empirical models. The focus of this study is on the relationship between the financial performance of Eskom and government debt, where government debt is the dependent variable. The Keynesian theory of government debt, its own debt and government debt is used to justify the use of government debt as a variable in the study. The second part of the chapter discusses various theories and the empirical literature that support the independent variables of the study. The theories are the neoclassical theory of the firm, the Miller and Modigliani theory, agency theory, stakeholder theory and the new institutional economics approach. The independent variables are revenue, price, staff, Eskom debt, and the current ratio and debt-to-assets ratio.

Chapter 4: Methodology

This chapter provides a strong methodological background to the study. The two empirical models used in the study were the VAR and ECM. The VAR model uses impulse response functions and forecast error decomposition analysis as the tools of the model's analysis. The ECM is constructed based on the assumption of cointegration amongst the long-run variables. After cointegration had been established, the ECM was constructed by taking into consideration the cointegrating component. Lastly, diagnostic tests were applied to the ECM to ensure that the model conformed to the conditions of Ordinary Least Squares (OLS) properties. The tests conducted were to ensure that there were homoskedasticity, no autocorrelation, no misspecification, and to ensure that the residuals of the ECM were normally distributed.

Chapter 5: Empirical Analysis

This chapter presents an outline of the results from the VAR and ECM. The results are discussed in accordance with the procedure of each model. However, prior to that, descriptive statistics, graphical analysis and unit root tests were conducted on all the variables used in the study. The unit root tests used were the Augmented Dickey-Fuller (ADF) and Phillips-Perron test. The VAR was estimated by determining the appropriate lag length and assessing the AR roots graph and table. The model was finally interpreted using impulse response functions and forecast error decomposition analysis. According to the notion of stationarity, it was expected that the variables in the VAR were all mean reverting. The ECM was also constructed using the two-step Engle Granger cointegration test, after which post estimation diagnostics were run.

Chapter 6: Conclusion

The study is concluded by this chapter where it reviews how the results have achieved the objectives. Recommendations of the study and areas of further research are also outlined in the chapter.

CHAPTER 2:

AN OVERVIEW OF STATE-OWNED ENTERPRISES, SOUTH AFRICAN DEBT AND THE ESKOM CRISIS

2.1 INTRODUCTION

The purpose of this chapter is to outline the background of the study. It starts with Section 2.2 which unpacks the notion of state-owned enterprises, including their positive and negative aspects. Section 2.3 is a discussion of South Africa's government debt. Section 2.4 presents a chronological discussion of Eskom from 1922 to the present day. The section includes significant events like the oil crisis, the De Villiers Commission and the Energy White Paper. Section 2.5 presents a more narrowed focus on Eskom's building programme which started in 2005, and load shedding which became more prevalent from 2008. Section 2.6, which is the crux of the study, discusses Eskom's financial statements, more specifically, its debt-to-assets ratio and current ratio. Eskom's debt, which is at the heart of this study's research problem, is also discussed in this section. Section 2.7 discusses corporate governance as a critical tool to any company's management structure. Section 2.8 discusses the privatisation of electricity in the United Kingdom (UK) and the United States of America (USA), and Section 2.9 concludes the chapter.

2.2 STATE-OWNED ENTERPRISES

State-owned enterprises (SOEs) are firms established by government to achieve the commercial and political objectives of the state. SOEs are usually located in industries such as electricity, infrastructure, banking and water supply. They have a large global footprint and contribute approximately 20% to global GDP (World Bank, 2014).

There are more positive than negative elements associated with SOEs. For example, in 2012, SOEs in North Africa and the Middle East accounted for 20-50% of value added, and 30% of total employment in the region (World Bank, 2014). In addition, in Indonesia, 150 SOEs account for 15-40% of its GDP (World Bank, 2014). These statistics indicate that SOEs still contribute to economic development, regardless of their regions and country of development.

SOEs are also important in providing markets in which the private sector would consider it too expensive to invest, or in which the private sector would ultimately overcharge for the respective goods and services (Lipczynski *et al.*, 2013:701). In addition, SOEs are the only firms which government can use as vehicles of socio-economic and political objectives. Eskom's electricity supply in South Africa is one such example.

While SOEs play an instrumental role in economic development, they also experience several challenges. Their biggest challenge is the fiscal risk that they present to the government. This occurs mainly through state-guaranteed loans, where SOEs are given more lax credit monitoring, face soft budget constraints, and are able to increase their debt levels without fear of liquidation or bankruptcy (World Bank, 2014; Xu, 2012:128). In a study comparing how the government and state-owned banks allocated credit to SOEs from 1980 to 1994, Cull and Xu (2002:533) found that direct government transfers were not significantly associated with profitability.

There is also little, to no, incentive for managers in SOEs to achieve full productivity, and the remuneration of managers is also not dependent on the organisation's performance. Therefore, there is also little incentive for sales maximisation, profit maximisation or even growth maximisation (Lipczynski *et al.*, 2013:701). Using accounting numbers, Dewenter and Malatesta (2001:320) conducted a large-sample cross-sectional comparison of SOEs and privately owned corporations from 1975 – 1995. They found that SOEs are less profitable than private firms. Although this study was conducted more than 20 years ago, the results are still comparable between private firms and SOEs today. Further challenges among SOEs are deteriorating fixed facilities, poor service quality, chronic revenue shortages, corporate governance, and large outstanding debt levels (Kessides, 2004:2).

In order to gain a deeper understanding of the challenges of SOEs, and specifically, those of Eskom, it is important to undertake empirical analysis. Many empirical studies support the literature on the challenges of SOEs. Using a sample of 85 companies from 28 industrialised countries that went through public share offerings for the period 1990-1996, D'souza and Megginson (1999) found that SOEs have lower profitability, lower output, lower operating efficiency, as well as high-level ratios, in comparison to their private counterparts. Megginson, Nash and Van Randenborgh (1994:403) also found similar results after using the panel data of 61 companies across 18 countries

from 1961 to 1990. They also found that only after being privatised do companies decrease debt levels, increase sales volumes, become more profitable, increase capital investment and operating efficiency.

According to the Department of Public Enterprises (2018), hereafter, DPE, in South Africa there are six SOEs directly owned by the government, namely, Transnet, Denel, Alexkor, South African Express, South African Forestry Companies Limited (SAFCOL) and Eskom.

Table 2.1: SOEs’ revenues and net profit/losses in 2017

	Denel	Eskom	Transnet	SA Express	SAFCOL	Alexkor
Revenues (millions)	8,057	177,136	65,478	2,327	1,014	386
Net Profit/Loss (millions)	333	800	2,765	(202)	114	6

Source: DPE Annual Performance Plan 2017/2018

Table 2.1 above shows the net profits/ revenues and losses for these six SOEs in 2017. An unaudited report of the SA Express financial statements has revealed a net loss of R202 million, with only a measly profit of R2,327 million when compared to other SOEs. Safcol and Alexkor are in a poorer financial standing with only R1,014 million and R386 million in revenue respectively.

According to the DPE’s Annual Performance Plan for the 2017/2018 financial year, SOEs are experiencing severe financial, operational and governance challenges.

The last decade has shown a considerable lack of financial performance by SOEs in South Africa which has required constant intervention from the government. This intervention has generally been in the form of bailouts, where the state has consistently been channelling funds into underperforming SOEs. The SOE which has received exceptionally high bailouts is Eskom.

2.3 SOUTH AFRICA'S PUBLIC DEBT

The National Treasury is the custodian of South Africa's National Revenue Fund, and is responsible for managing the government's finances (National Treasury, 2019). One of its other roles, which relates to SOEs, is ensuring sustainable public financial management and maintaining good governance. However, even though this is the case, SOEs have put strain on the role of the National Treasury because of the pressures they exert on the fiscus.

According to the Public Financial Management Act (PFMA) No.1 of 1999, the national government is allowed to borrow for five of the following reasons (National Treasury 2008; PFMA 1999):

1. Financing the national budget deficit;
2. Refinancing maturing debt or a loan redeemed before the maturity date;
3. To obtain foreign currency;
4. To maintain credit balances on a bank account of the National Revenue Fund; and
5. To regulate the domestic money situation should the need arise.

While the PFMA has clearly stipulated the reasons for borrowing, Treasury has conceded that although in theory they should borrow only to finance capital expenditure, government's total debt also includes debt to finance current expenditure. Borrowing is also being used to provide state-guaranteed loans, mostly for Eskom.

A government guarantee is a loan that a third party agrees to in the event that the borrower defaults, while exposure is how much of the guarantee the borrower uses (Liu, Lyu & Yu, 2017). According to Julies (2018), the combined financial position of public institutions has been weak, while their government guarantee and exposure have been high and increasing every financial year.

Table 2.2 shows all public institutions', the total government guarantee and exposure. Amongst all the public institutions, Eskom constitutes on average, 75% of government guarantees and exposure. This shows how much of a contingent liability Eskom is to the public purse.

Table 2.2: Government guarantees and exposure

R billion	2015/2016		2016/2017		2017/2018	
	Guarantee	Exposure	Guarantee	Exposure	Guarantee	Exposure
Public Institutions of which:	469,9	255,8	475,7	290,4	466,0	300,4
Eskom	350,0	174,6	350,0	202,8	350,0	220,8
SANRAL	38,9	27,2	38,9	29,4	38,9	30,1
Trans-Caledon Authority	25,8	21,2	25,6	20,9	25,7	18,7
SAA	14,4	14,4	19,1	17,8	19,1	11,8
Land & Agricultural Bank of South Africa	6,6	5,3	11,1	3,8	9,6	6,6
DBSA	13,9	4,4	12,5	4,1	12,3	4,2
SA Post Office	4,4	1,3	4,4	4,0	0,4	0,4
Transnet	3,5	3,8	3,5	3,8	3,5	3,8
Denel	1,9	1,9	1,9	1,9	2,4	2,3
SA Express	1,1	0,5	1,1	0,8	0,8	0,8
IDC	2,0	0,2	0,4	0,2	0,5	0,1
SARB	3,0	-	3,0	-	-	-
Independent Power Producers (IPPs)	200,2	111,4	200,2	125,8	200,2	122,2
Public-Private Partnerships	10,3	10,3	10,0	10,0	9,6	9,6

Source: Julies (2018)

According to Julies (2018) and Everaert, Fouad, Martin and Velloso (2009), SOEs' financial pressures lead to several fiscal risks, namely, macroeconomic risk, direct funding pressure, and the build-up of long-term liabilities. When SOEs face revenue underperformance this worsens the government's fiscal ratios and leads to adverse macroeconomic pressures, such as high inflation and weaker economic growth. Their underperformance also leads to negative pressure from sovereign credit ratings (Paton, 2019).

As a remedial measure, the state can resort to tax increases or spending cuts to channel funds to the respective public institutions. This can have a negative effect on service delivery and economic growth. It can also create a tax burden which undermines social equity (Hyman, 2011; Rawdanowicz, Wurzel & Christensen, 2013).

South Africa faced significant credit downgrades in 2017 from the top four global rating agencies, Fitch; Moody's; Ratings & Investment Information, Inc., as well as Standard & Poors (S&P) (National Treasury Budget Review, 2018:82). This was due to low economic growth and the policy uncertainty surrounding SOEs, particularly Eskom. As a result, the respective agencies categorised South Africa's economy according the statuses in Table 2.3, where their outlook was between stable and negative (Chartered Financial Institute, 2017:12-13).

Table 2.3: South African credit downgrades in 2017

Rating Agencies	Long-Term Foreign Currency (LTFC)	Long-Term Local Currency (LTLC)	Outlook
Fitch Ratings	BB+ (Sub-investment grade)	BB+ (Sub-investment grade)	Stable
Moody's Investors Service	Baa3 (Investment grade)	Baa3 (Investment grade)	Negative
Ratings & Investment Information, Inc.	Baa3 (Investment grade)	Baa3 (Investment grade)	Negative
S&P Global Ratings	BB (Sub-investment grade)	BB+ (Sub-investment grade)	Stable

Source: National Treasury (2018)

The National Treasury has maintained a prudent management of debt to increase its borrowing requirement, regardless of its debt challenges. However, along with inflation, exchange rate risk, and global interest rates, the National Treasury cites its fiscal position as one of the risks to its financial strategy. By fiscal position, they refer to increases in the fiscal deficit or calls on guarantees to, or bailouts for, state-owned companies (National Treasury, 2018: 23).

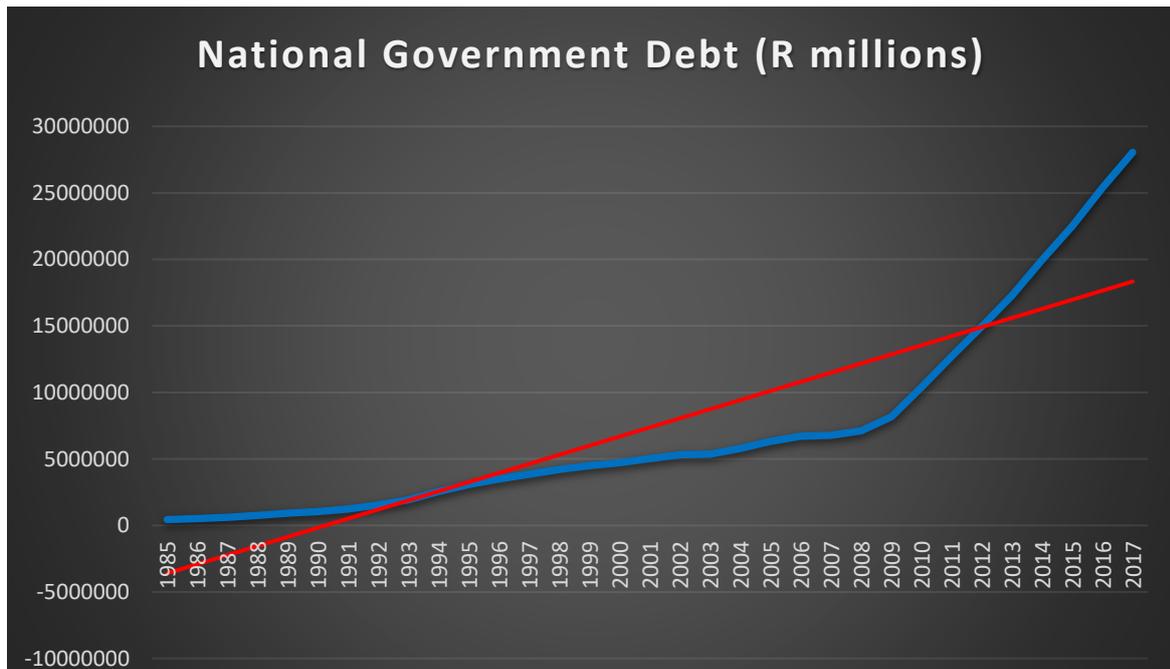


Figure 2.1: South Africa's overall national government debt (R millions)

Source: Quantec Easy Data (2019)

Figure 2.1 shows South Africa's overall national government debt from 1985 to 2017. Since 1985, national government debt has been steadily increasing. The steady increase has been from R44, 0327 million in 1985 to R123, 7931 million in 1991. From 1992, the increases in national government debt have been increasing at a faster rate, with the sharpest increase being from 2008 at R712, 1567 million, and reaching its peak at R280, 524, 56 million in 2017. Since then, the increase in the debt has been steep.

While it is noteworthy to attribute the large increase in national debt to SOEs, another factor must be mentioned. From 1989 to 1994, the government improved the actuarial funding of the Government Employees Pension Fund (GEPF) (Calitz, Du Plessis & Siebrits, 2011). The interest burden on government debt has also increased substantially due to debt-service costs. According to Mbeki, Rossouw, Joubert and

Breytenbach (2018), these costs increased from R52,9 billion in 2007/2008 to R187,8 billion in 2018/2019.

Everaert *et al.* (2009) note that fiscal risks can arise when the government constantly intervenes to rescue underperforming SOEs, which is the case with the Treasury and Eskom. However, the state has to intervene to remedy this mounting fiscal challenge. Julies (2018) postulates three options for dealing with SOEs in distress:

- Firstly, he suggests the issuing of new guarantees which will lead to a build-up of unserviceable debt. However, this may not be possible because lenders will not be willing to extend more credit, despite the guarantee from the state.
- Secondly, he suggests supporting an entity only by paying its interest payments. This sounds more effective at reducing the upward trend in government debt.
- The third option is an outright bailout. Although this can be positive in that the SOE will no longer have unsustainable debt, an outright bailout is a strong indicator that they may need another bailout again in the future.

However, there is a fourth fiscal option that appears to have desirable results, and it can be found in the growing literature on fiscal consolidation. Fiscal consolidation is a package of instruments which a state can use to decrease its accumulation of debt. A state qualifies for fiscal consolidation if it has high inflation, weak economic growth, and high debt. Rawdanowicz *et al.* (2013) and Alesina (2012) advocate for consolidation through spending or a 'fiscal squeeze'.

Rawdanowicz *et al.* (2013) note that when fiscal consolidation is implemented from an expenditure perspective, the main instrument utilised for this is the reduction in government transfers. While this may have negative effects on transfers, such as social grants and unemployment benefits, it will have a positive effect on the fiscus by reducing transfers to SOEs. A large spending cut to SOEs can lower the debt-to-GDP ratio and is less detrimental to the economy.

2.4 ESKOM

In order to get the full context of the events leading to Eskom being a fiscal risk to the state, this section will present a chronological discussion of Eskom, starting at 1922 and ending at 2019. The timeline will include the following topics: Eskom's historical

background; the oil crisis; the De Villiers commission; Energy White Paper; Eskom's building programme and load shedding.

2.4.1 Historical background

The name Eskom is derived from ESCOM, the English acronym for the 'Electricity Supply Commission', as it was previously known (McDonald, 2008). Not only has the utility been instrumental in the success of the mining industry, but also in industrial development as a whole in South Africa (Eberhard, 2004).

Eskom is a vertically integrated power utility, and since its inception in 1922 by the Electricity Control Board, its structure has largely remained unchanged. In 1948, Eskom bought out the last major private generator of electricity, thereby extinguishing its competition. Eskom, therefore, is a monopoly in the South African electricity supply industry, and its supply chain includes electricity generation, transmission and distribution (Eberhard 2004; Gigler & McMillan, 2018:1).

Eskom has 13 coal-fired power stations which account for 85% of Eskom's total net capacity. They are Arnot, Camden, Duvha, Grootvlei, Hendrina, Kendal, Komati, Kriel, Matla, Tutuka, Majuba, Lethabo and Matimba. All the stations are located in Mpumalanga, except for Lethabo and Matimba that are located in the Free State and Limpopo, respectively (Development Bank of Southern Africa (DBSA), 2012; Eskom, 2018b).

Eskom's other 10 power stations generate electricity through gas, hydroelectricity, nuclear energy, renewables and thermal energy. The gas and nuclear-powered stations, including Eskom's wind farm, are all in the Western Cape. The hydro stations are in the Northern Cape and on the border of the Free State and Eastern Cape. Eskom also owns 300 000 kilometres of national transmission lines, while it shares the distribution chain with a few local municipalities (DBSA, 2012).

Figure 2.2 (on the next page) shows South Africa's electricity infrastructure network.

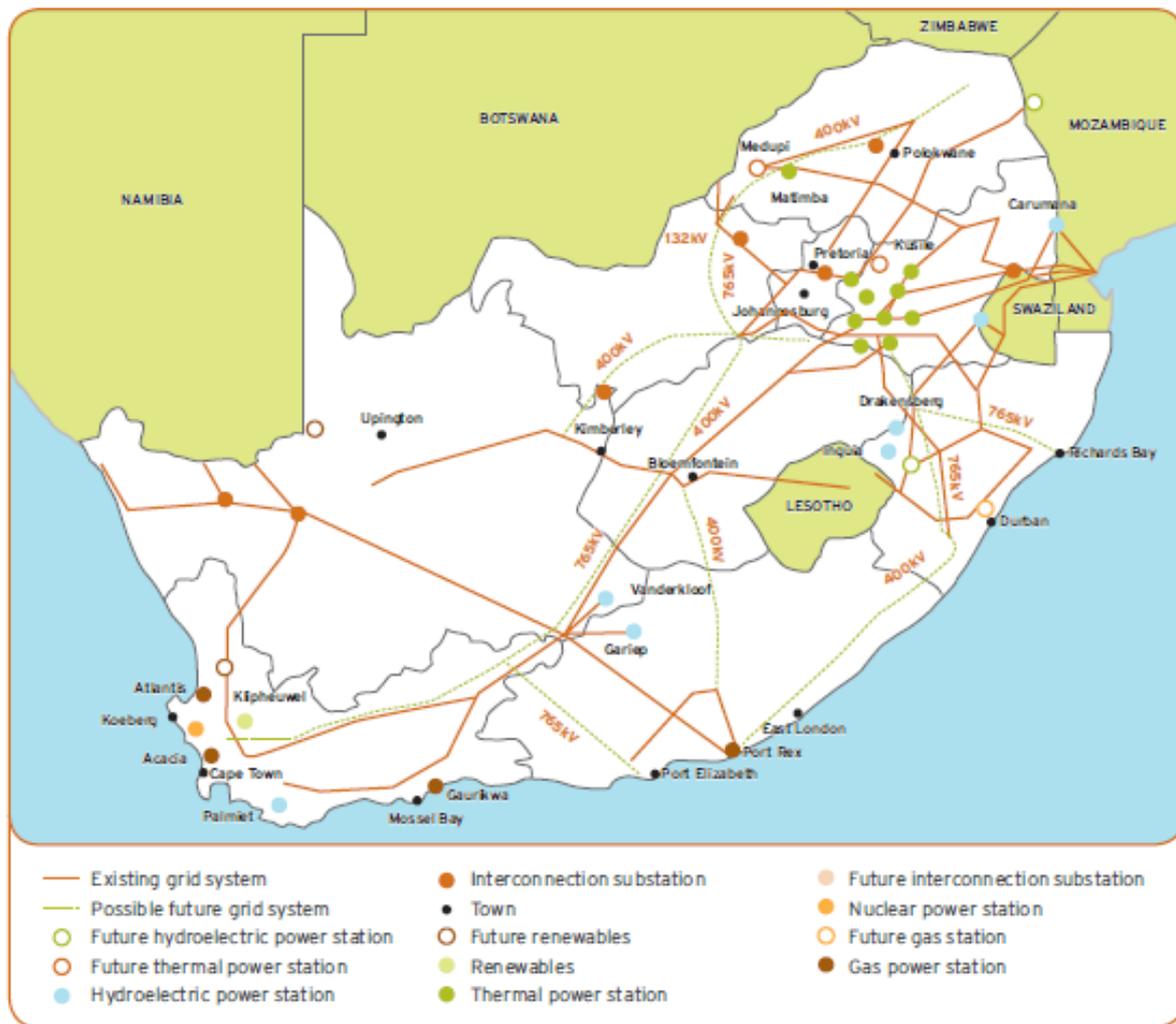


Figure 2.2: South Africa's electricity infrastructure network

Source: Development Bank of South Africa (2012)

As a monopoly, Eskom has competitive advantage in the power industry because of its capital, technology, infrastructure, assets, size, and number of years in operation (Varian, 2010, Klimczak, 2007). As such, there are significant barriers to entry in the electricity supply industry. Since the power sector has outright imperfect competition, it is important that it has a regulator.

The official regulator of the electricity industry is the National Energy Regulator of South Africa (NERSA). Its mission, according to the National Energy Regulator Act of 2004, is "to regulate the energy industry in accordance with government laws and policies, standards and international best practices in support of sustainable and orderly development" (NERSA, 2018:1). NERSA, among its other responsibilities, is the regulator involved in approving or declining applications for electricity tariff increases or decreases from Eskom.

2.4.2 Oil crisis

The oil crisis of 1973 was an opportune event for Eskom as it led to a sharp increase in its customer base. This was due to the fact that customers changed to electricity, as other fossil fuels, such as oil and gas, became too expensive (Steyn, 2016). This increase in consumer demand for electricity meant that Eskom had to initially decrease prices in order to capture the market. However, as the demand increased even further, it was forced to raise prices to expand the number of generation plants, and ultimately maintain supply.

Steyn (2016) notes that because of this, electricity prices increased by 70% in real terms between 1974 and 1978. Since electricity generation at this time depended largely on coal, it was expensive to maintain power plants without increasing prices. The Government Technical Advisory Centre (GTAC), an agency of the National Treasury, has reported that when comparing the cost of power generation technologies, coal and nuclear generation are the most expensive (GTAC, 2018). Subsequently, there was another increase in prices in 1983.

2.4.3 De Villiers Commission

In 1984, there was a revolt against the electricity price increase by Eskom in 1983. This resulted in protests dubbed “Stop the Rot”. The government was then forced to intervene, and it did so by appointing the De Villiers Commission to evaluate Eskom’s operational and financial management. Kantor (1988) highlights the fact that the De Villiers Commission advocated for debt management driven tariffs. It recommended that Eskom should not charge prices which are cost-reflective, but should rather charge prices that are consumer-privileged. This was due to the government believing that South Africans could not afford to pay electricity tariffs which reflect long-term marginal costs. However, one can also deduce that the state was under political pressure and sought a quick solution.

This study cannot overstate enough how much of a blunder this was on the part of government. Eskom is in a crisis today because it has not charged cost-reflective tariffs since 1984, and this has proved to be unsustainable. Deon Joubert, a Chartered Accountant (SA), who is a member of the cost-structuring team at Eskom, expressed the same sentiment at a recent seminar hosted by the University of South Africa’s

(UNISA's) Economics department (UNISA, 2019). He also advocates for electricity prices that are cost-reflective and that will enable Eskom to pull itself out of debt.

Kantor (1988) further argues that in order to justify investments in generation plants, price escalation over time is necessary. He also points out that the De Villiers Commission proposed increases in electricity prices only when there is an increase in inflation. This recommendation is flawed because if inflation decreases or remains generally consistent, it implies there is no inflow of funds for Eskom to maintain its generation plants. This compromises Eskom's financial stability because its debt obligations are independent of inflation adjustments. The utility then finds itself with increasing debt levels that cannot be offset by revenue.

On 6 February 1988 an announcement was made that Eskom would be privatised (Van der Heijden, 2013). However, a retraction subsequently followed after Eskom did its own study and found that privatisation was not feasible.

Figure 2.3 below is a graphical illustration of the historical average electricity prices (in cents per kilowatt) from 1985 to 2017.

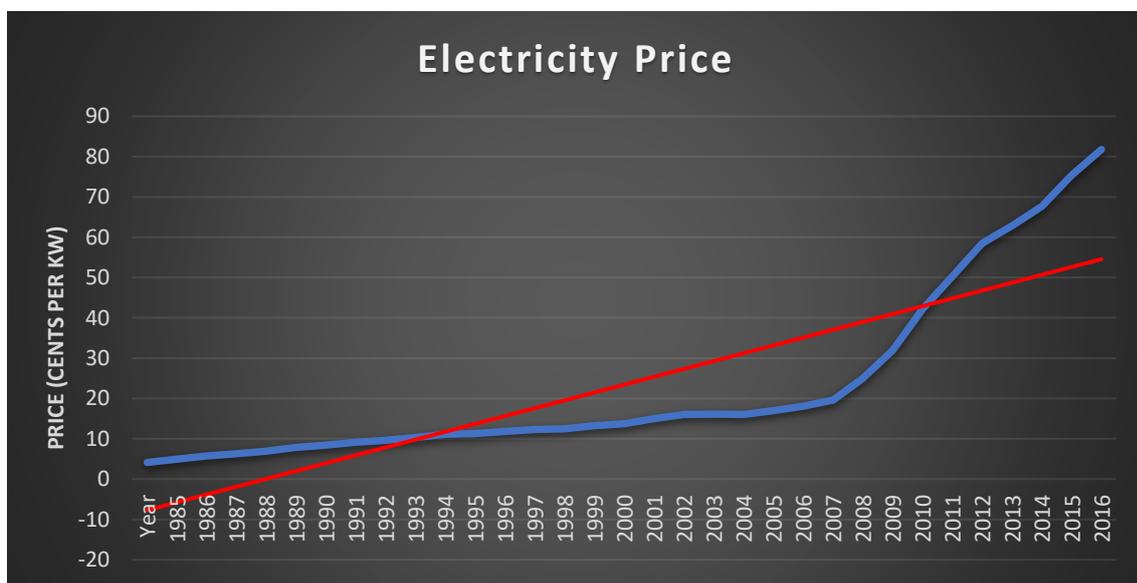


Figure 2.3: Historical average electricity prices: 1985-2017

Source: Eskom Financial Statements (1985-2017)

Figure 2.3 shows the movements in the electricity price between 1985 and 2017, where the red line represents the trend. In the late 1970s, there were high electricity price increases due to the electricity demands previously mentioned (Storer & Teljuer, 2004:4). Electricity prices remained relatively flat throughout the middle 80s to the end

of the 90s due to the recommendations of the De Villiers Commission. During this period, households and firms were relatively price inelastic to minor increases in the electricity price (Gigler & McMillan, 2018:1). In 2011, Inglesi-Lotz and Blignaut conducted a panel data study where they found that between 1993 and 2006, South Africa's industrial sector had a statistically significant negative price elasticity of demand of -0.869 to historical electricity price increases (Gigler & McMillan, 2018:3). Table 2.4 (on the next page) takes a closer look at the historical average electricity price increases per year from 2004 to 2017.

Table 2.4: Historical average price increases: 2004 – 2017

Year	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Local-authorities	-0.36%	6.22%	4.62%	7.90%	27.89%	32.38%	28.17%	21.51%	13.68%	11.13%	8.66%	12.42%	9.80%
Residential	5.80%	3.56%	4.14%	6.76%	19.88%	19.76%	3.86%	16.64%	12.31%	6.17%	6.11%	10.26%	9.70%
Commercial	6.14%	3.68%	3.58%	5.75%	27.20%	29.60%	28.45%	21.45%	14.59%	12.86%	7.86%	12.23%	9.02%
Industrial	-1.31%	4.75%	9.40%	7.93%	25.49%	24.66%	27.02%	16.83%	13.56%	13.67%	9.71%	10.25%	8.10%
Mining	1.95%	5.35%	4.41%	6.47%	28.49%	30.84%	31.50%	20.93%	15.88%	16.00%	7.52%	12.22%	8.70%
Agriculture	5.79%	6.58%	2.52%	6.61%	27.47%	28.80%	23.33%	19.94%	14.37%	9.02%	6.36%	10.83%	10.54%
Traction	2.06%	4.55%	3.93%	10.75%	27.75%	28.36%	27.01%	15.83%	22.08%	12.65%	8.13%	15.50%	8.64%
International	9.71%	13.95%	13.41%	27.05%	30.28%	21.76%	38.14%	18.32%	16.33%	11.32%	10.49%	13.84%	18.31%
Internal	19.76%												
Average price adjustment %	0.05%	6.01%	6.18%	8.52%	27.40%	27.96%	32.08%	19.13%	16.35%	7.39%	7.67%	11.46%	8.48%

Source: Eskom (2018), NERSA (2018)

Table 2.4 above shows the historical average electricity price increases per category of users. According to Blom (2018), the correct price of electricity today would be 40c/KWh, instead of the official tariff of R1,09. Consumers on prepaid electricity pay even more, at R4,54/KWh.

2.4.4 From democracy to energy restructuring

Given the historical injustices of the apartheid regime, many previously disadvantaged persons were not connected to the electricity grid. Therefore, one of the socio-economic objectives of the new government was to electrify as many homes as possible. Eskom was the main vehicle through which this was achieved because of it being owned by the state.

In 1994, South Africa became a democratic country. However, the electrification of more households had already begun prior to this. According to Eskom (2019), in 1993 there were 300 000 electrifications countrywide, where two thirds were done by Eskom and the other third by municipalities. This process has been formally encapsulated in the Department of Energy's (DME) (2014) Integrated National Electrification Programme (INEP). According to the DME, access to electricity was at only 36% in 1994, and it increased to 88% in 1994. The highest number of electrifications done during this period were in the Eastern Cape, KwaZulu-Natal and Limpopo.

An important policy, called the Energy White Paper, was drafted in 1998 (DME 1998). Its overarching goal was to restructure the energy sector in South Africa, given some challenges which had been identified in the sector. These challenges were that although there was excess electricity supply capacity at the time, growth in electricity demand was projected to exceed generation capacity by 2007 (White Paper, 1998). The distribution of electricity by municipalities still had challenges of mass defaults, theft of cables, and as a result, increasing arrears. Another challenge was that coal-based generation had been identified as a large carbon emitter, which had long-term adverse effects on the environment.

In her study, Van der Heijden (2013) noted that the White Paper envisaged Independent Power Producers (IPP) being introduced into the power sector, together with the restructuring of Eskom into generation and transmission companies. This was a key opportunity for enhancing Black Economic Empowerment (BEE) and private investment. In addition, the government intended to encourage competition by also

giving the IPPs access to the transmission infrastructure. In response to this, Eskom closed its New Works department in 2001, a department which was responsible for generation capacity at the utility. Eskom took this action because of government’s anticipated electricity supply from the IPPs (Van der Heijden, 2013). It is critical to note that this was another erroneous action by the government. They allowed Eskom to stop any further building of generation plants before ensuring that IPPs would come on board.

As is commonly known, an increase in market competition often involves some degree of privatisation, which often results in job losses. In 2001, the Congress of South African Trade Unions (COSATU) was successful in opposing the partial privatisation component of the Eskom Conversion Act, No.13 of 2001, because IPPs were said to be the new custodians of electricity supply. Their main argument was the protection of thousands of jobs at Eskom.

Figure 2.4 below is a graphical illustration of the staff numbers at Eskom from 1985 to 2017.

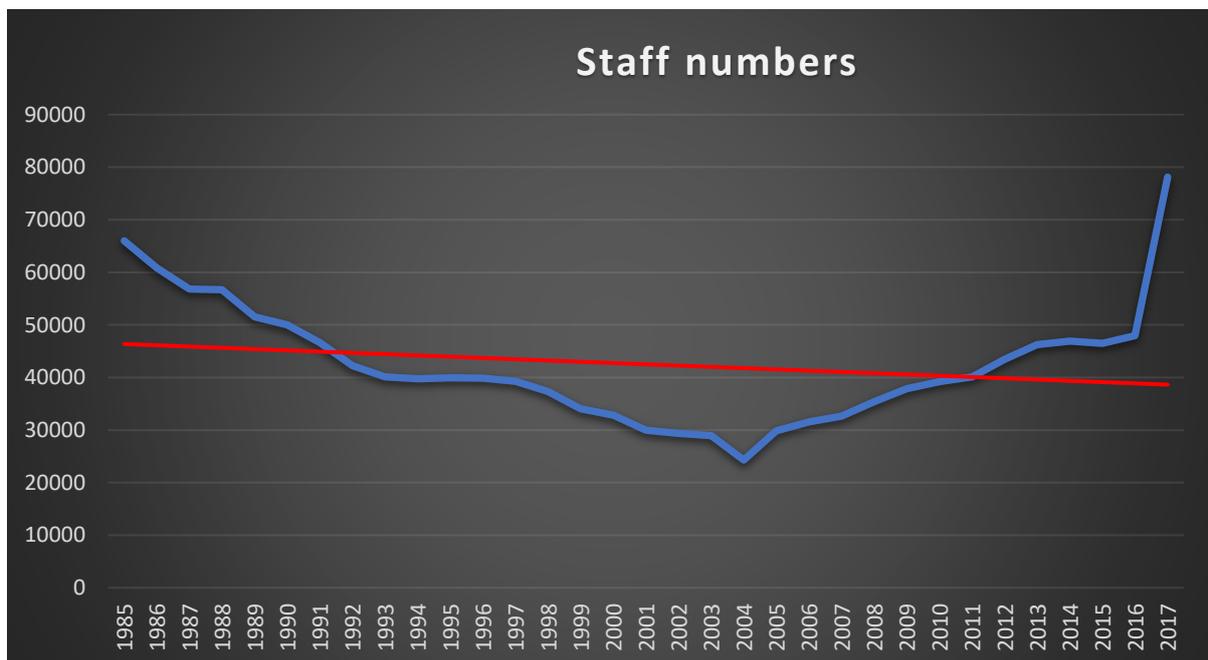


Figure 2.4: Eskom staff numbers from 1985-2017 (thousands)

Source: Eskom Financial Statements (1985-2017)

Eskom is the SOE with the largest number of employees. As can be seen from Figure 2.4, the general trend of employment at Eskom is downward, especially from 1985 to 2004. However, the sharpest decline occurred from 1985 to 1992, after John Maree

became the chairman of the Electricity Council in 1985. When he assumed his position there were 66 000 staff members, and management had projected that to increase to 72 000 in 1986. Maree believed that Eskom could function with less staff and by the end of 1986, he had reduced the staff complement to 60 800. By the early 1990s, he had reduced Eskom's staff numbers to 50 000 (Eskom, 2018).

Given this data on employment at Eskom, it can be inferred that there has generally been a limited production of output as a result of the low staff numbers between 1990 and 2012, at 50 000 and 43 473 respectively (Snowdon & Vane, 2005). From 2005, employment started to pick up owing to the significant measures the corporation undertook towards skills development. This occurred in the form of learnerships, bursaries and general technical training. In 2005, Eskom had 1 568 bursary-holders and trainees, 85% of which were black and 55% women (Eskom Annual Report, 2005:93). Yet this increase in recruitment has not assisted in pushing the building programme forward.

2.5 FINANCIAL CRISES AT ESKOM

This section discusses financial crises at Eskom in terms of the Eskom building programme and load shedding.

2.5.1 Eskom building programme

Between 2001 and 2004, IPPs failed to come to the market, and the government started to instruct Eskom to build its own generation capacity, after it had closed its New Works department some three years before. This would mark the beginning of Eskom's financial crises, including load shedding. Eskom's building programme started in 2005, and has still not been completed to date, despite constant requests for funds from the government. To date, the programme has cost R213,2 billion, excluding capitalised borrowing costs (Eskom, 2018).

The building programme started with the Medupi power station and a part of Kusile. Over the years, Eskom has started new projects that include pumped storage, a wind farm, and a general strengthening of the grid.

Since 2008, Eskom's management has been heavily frowned upon by business and citizens alike due to the electricity blackouts that started in 2007. The public perception of Eskom has worsened over the years. This is not only because of the blackouts but

the incredulous scale of access to funds which Eskom has been given, with the state acting as a guarantor of its debt (Liu *et al.*, 2017). Eskom has had access to equity injections, government loans and the capital market. According to the DBSA (2012), Eskom has had accessed to even more types of funds through the African Development Bank, export credit agencies, commercial paper and other resources.

In 2008, the then Minister of Public Enterprises, Alec Erwin announced a R60 billion equity injection into Eskom, after NERSA's approval of Eskom's tariff increase at that time (IOL, 2008:1). The R60 billion was approved to enable Eskom to recover its primary energy costs over a five-year period. This means that the government injected cash or capital into Eskom's balance sheet in order to make the utility more attractive for more access to credit. When the media asked the Minister whether this injection would contribute to Eskom's building programme, he was evasive and stated that there was no clear indication of what this injection would be used for and that it was merely shareholder support (IOL, 2008:1).

One has to stop at this point to ask, can Eskom be held entirely responsible for this situation? The short answer is certainly not. Eskom were informed that their generation capacity would no longer be needed, which led to them closing down their New Works department, which had to be consequently reopened after about four years.

However, this is not to say Eskom is totally exempt from any accountability regarding its building programme. Eskom's access to funds from capital markets also meant they received R12,25 billion for the issuance of global bonds in 2010 (Creamer, 2011:1). So this begs the question why all these funds are not sufficient to complete a building programme that started 15 years ago. Unfortunately, the oversubscription of Eskom's bonds has attracted even closer monitoring and scrutiny from credit rating agencies. This is because many international investors have taken on the risk associated with Eskom's bonds. Furthermore, the utility's constant financial crises, as well as fraud and corruption cases, only attract heavier credit scrutiny.

In his study of Chinese SOEs, Cheng (2004) found that SOE managers enriched themselves by abusing their power. In the same vein, Nguyen and Van Dijk (2012) also found that corruption in Vietnamese SOEs is rife and has a negative effect on economic growth. It is only through upgrades, such as the one by Moody's on 5 April 2018, that the utility's global reputation manages to stay afloat (Moody's, 2018:1).

2.5.2 Load shedding

Eskom's poor service quality is characterised by power outages which started from 2007, were at their peak from 2008 to 2010, but slowly improved thereafter. Several claims from the media attested to coal quality and low reserve margins as the major drivers of load shedding.

The most significant price increases occurred during 2008 and 2010, a period during which the country experienced a significant number of load shedding disruptions. Fraud and corruption cases, as well as cash injections from the state, were also at their peak during this period.

Load shedding had a significantly adverse impact on businesses and productivity during this period. Evidence of this is found from Gigler and McMillan's (2018:5) study where they calculated the net present values of energy-intensive and moderately energy-intensive firms' operating profit. Although their focus was more on firms in the mining industry in which electricity is a large production input, their study extrapolated data until 2041. They found that the largest declines in operating profit were from the most energy-intensive firms, namely, Evraz Highveld Steel (17,1%), Implats (14,1%), and PPC (12,4%) when extrapolated in a high-tariff scenario (Gigler & McMillan, 2018:5).

From 2008, there has been a significant increase in electricity prices. According to economic theory, an efficient price is one which is equal to marginal cost (Pindyck & Rubinfeld, 2013). This is not the case, since Eskom is a monopoly that is able to manipulate the electricity price. Since 2008, Eskom has been making frequent applications for tariff increases which they started to justify as necessary to avoid power outages. According to Altman (2008:2), Eskom's proposed price increases enable unnecessarily fast repayments of loan finance and exceed what is required to maintain credibility with its creditors.

However, one can also consider the fact that the price increases may be necessary to contribute to maintaining Eskom's property, plant and equipment as well as its other infrastructure, given the fact that prior significant price increases were only in the 1970s.

2.6 ESKOM'S FINANCIAL STATEMENTS

Global financial accounting and reporting provides important tools to assess a company's financial standing. The most important tools for such an assessment are the annual financial statements which all commercial companies produce annually. Annual statements comprise of the following items: the income statement; the balance sheet; notes to accounts; statement of cash flows; the audit report and the statement of changes to equity (Walton & Earts, 2009:5).

While all the above-mentioned items are important, the study will focus on the income statement, balance sheet and notes to accounts. The income statement is the main performance indicator of profitability, while the balance sheet gives a picture of how the company has been financed, and how that money has been invested in productive capacity (Walton & Earts, 2009:4).

While it is useful to have financial statement data in whole numbers, there needs to be a more uniform measure to compare and understand all data on the same standard. One of the uniform standards is financial ratio analysis (Walton & Earts, 2009:238). According to Kumbirai and Webb (2010), financial ratio analysis is effective in distinguishing high performing companies and those that are not performing well. There are several ratios, such as management performance ratios that include profitability ratios and asset utilisation ratios. There are also financial strength ratios that include long-term solvency risk ratios and short-term liquidity risk ratios.

The study will use the aforementioned financial strength ratios, in particular, the debt-to-assets ratio and the current ratio:

- A current ratio measures the ability of a company to pay off its short-term debt without disturbing normal operations (Walton & Earts, 2009:247). It is calculated as current assets divided by current liabilities.
- The debt-to-assets ratio is a solvency ratio and is an indicator of stability and risk (Odaló, 2016). It essentially calculates how much of the business is owned by the company and how much of it is financed by debt. It is calculated as total liabilities divided by total assets.

As with all commercial companies, Eskom’s financial statements are the best determinant of financial performance because trends, calculations and inferences can be made from these.

2.6.1 Eskom’s current ratio

Figure 2.5 below is a graphical illustration of Eskom’s current ratio for the period 1985 to 2017.

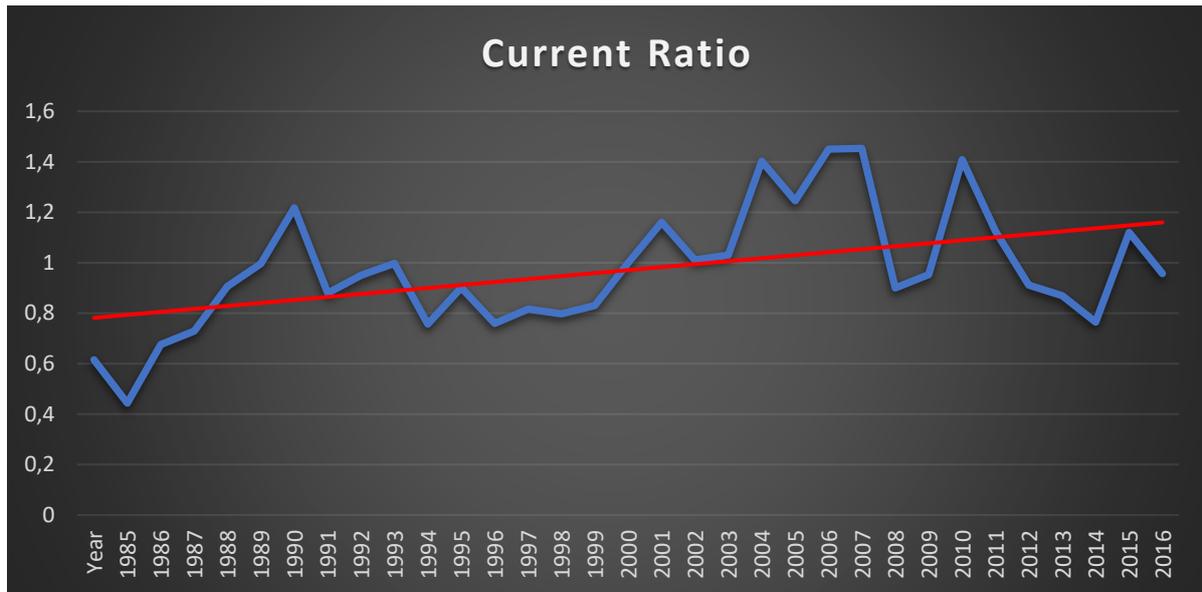


Figure 2.5: Eskom’s current ratio: 1985-2017

Source: Eskom Financial Statements (1985-2017)

Figure 2.5 above shows Eskom’s current ratio between 1985 and 2017. A low current ratio of less than 1 indicates that a company will not be able to pay off its short-term obligations, even if it can liquidate all its current assets (Odalo, 2016). However, a high current ratio of greater than 1,5 implies that the company is highly liquid, which means that it would be able to pay off its short-term obligations by selling its current assets at a high value (Odalo, 2016).

The upward trend of Eskom’s current ratio does not mean it is generally moving towards a strong range of liquidity. Throughout the sample period, Eskom has been relatively illiquid, and never obtaining a current ratio that is greater than 1.5. Eskom was most illiquid during 1985 with a current ratio of 0,44, well below the number 1 mark. Its subsequent troughs were in 1991 (0,88), 1994 (0,76), 1996 (0,76), 2008 (0,9), and 2014 (0,76). The period between 1996 and 1999 was relatively flat.

While these ratios show the financial position at Eskom as being weak, it is noteworthy that this was during the times were electricity prices were generally flat. Therefore, the lack of increases in price could have negatively impacted its financial position. During 2008 and 2017, the highest current ratios were in 2010 (1,4) and 2015 (1,2). While these aforementioned ratios show positive information about the utility’s financial position, it must be borne in mind that this was the period in which Eskom had the R60 billion equity injection from the state through NERSA’s tariff increase approval in 2008.

The R60 billion mentioned above was approved for Eskom to recover its primary energy costs over a five-year period. Eskom’s access to funds from capital markets meant they received R12,25 billion for the issuance of global bonds in 2010, which also had the effect of improving Eskom’s current ratio (Creamer, 2011). Therefore, the current ratio can be affected by many financial developments.

2.6.2 Eskom’s debt-to-assets ratio

Figure 2.6 below shows Eskom’s debt-to-assets ratio from 1985 to 2017.

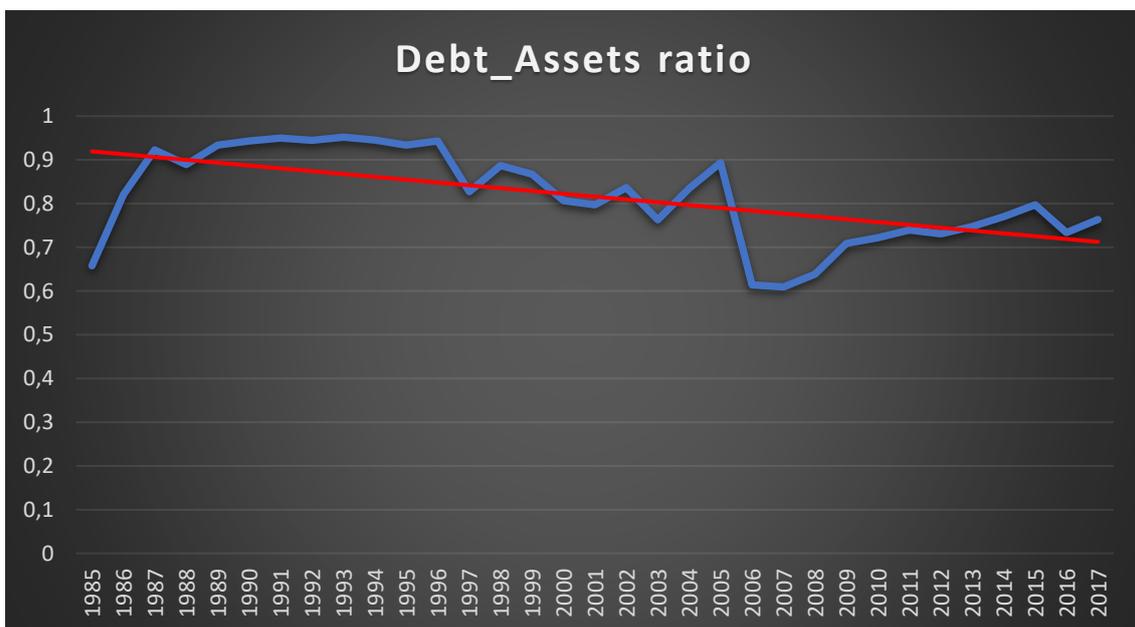


Figure 2.6: Eskom’s debt-to-assets ratio: 1985-2017

Source: Eskom Financial Statements (1985-2017)

A high debt-to-assets ratio implies that there is a high risk for financial distress since there is high financial leveraging (Odaló, 2016). A debt to asset ratio of less than 30% or 0.3 is desirable, while a ratio higher than this shows that the company’s leverage is high, so it is in a weak financial position.

The general state of Eskom is one of financial distress. As a result, the data only confirm the details in the financial statements. Even though the debt-to-assets ratio trend has been generally downwards from 1985 to 2017, it has still been on average, above 30%. Throughout the entire period, the debt-to-assets ratio has been at a minimum of 60%, with its highest being close to 100% between 1987 and 1996. There was a significant decrease in the debt-to-assets ratio between 1997 and 2003, with a peak at 2005, a trough at 2006, and a peak again in 2008 which sparked another upward trend. Overall, Eskom uses debt financing for its operations because they are so close to a debt-to-assets ratio of 100%.

Eskom has also been facing a majority of negative working capital from 1985 to 2017 (Eskom Financial Statements; 1985 - 2017). This implies that if they were not an SOE, they would soon declare bankruptcy or insolvency. So, given the fact that they are backed by the state guaranteed loans, lax credit monitoring and soft budget constraints, the debt-to-assets ratio almost has no relevance. Nevertheless, it is important for this study to illustrate how much of a burden Eskom is on the fiscus.

In conclusion, it needs to be mentioned that

2.7 ESKOM'S DEBT

Figure 2.7 below provides a graphical illustration of Eskom's debt from 1985 to 2017.

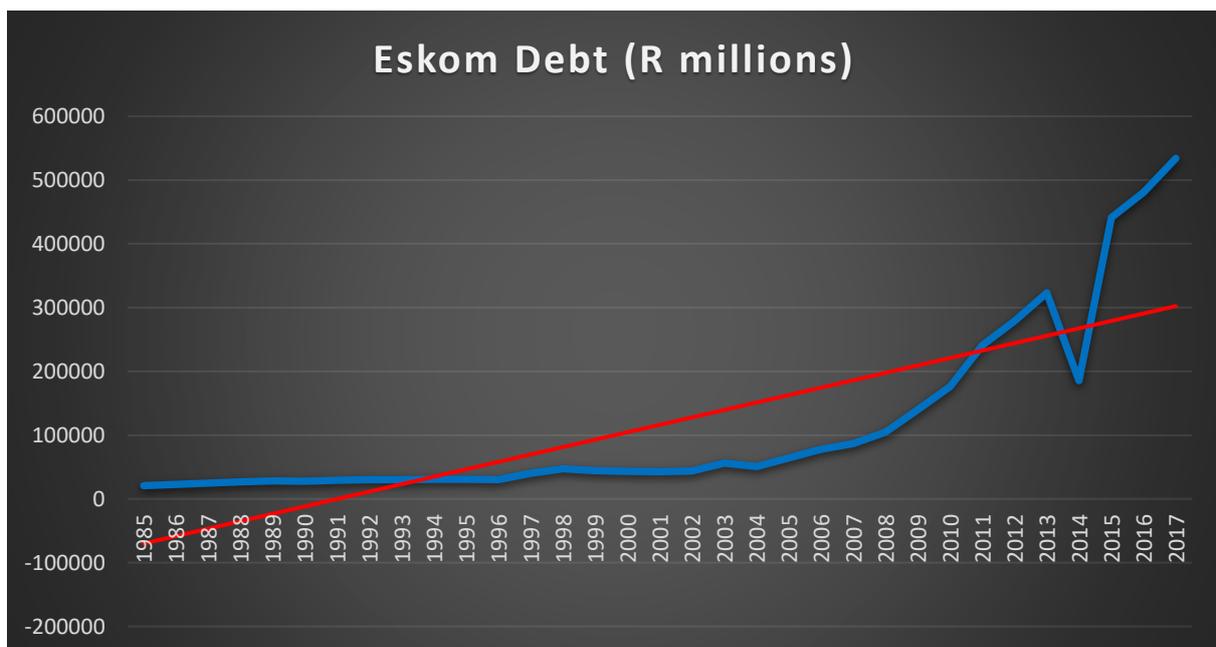


Figure 2.7: Eskom debt (R millions)

Source: Eskom Financial Statements (1985-2017)

Figure 2.7 above shows that throughout the sample period, Eskom's debt has increased sharply from R20,747 million in 1985 to R534,067 million in 2017. For example, the figure shows that the debt in 1985 was only 3,88% of the debt in 2017. Eskom's debt was significantly lower in 2014 at R185,414 million, but thereafter increased to R441,269 million in 2015.

Another factor to consider and that influences the graph in the figure above, is that the R60 billion loan injected into Eskom in 2008 was also a response to credit downgrades. Initially, R30.5 billion of this loan was classified as equity, and the remaining R29.5 as loan liability. On 31 May 2015, the loan portion was also converted to equity under the Eskom Special Appropriation Bill and Eskom's Subordinated Loan Special Appropriation Amendment Bill (Government Gazette, 2015). This conversion of the loan was also another effort to appease credit rating agencies, while also freeing up Eskom's borrowing capacity. Nevertheless, this form of state guarantee is the paramount reason for Eskom's mounting debt and Figure 2.7 shows that this debt will continue to increase.

2.8 CORPORATE GOVERNANCE

It is evident that the financial health of Eskom is a significant determinant of its financial performance. However, another managerial strategy that can assist is to implement appropriate corporate governance measures. Corporate governance refers to the systems and structures by which firms are controlled (Lipczynski *et al.*, 2013:121). Challenges to these systems and structures arise because of a conflict of interest between the principal and the agent regarding the maximisation of company value. This conflict of interest is mitigated through various systems, such as a board of directors, dividend policy, executive compensation, share ownership and market competition for products and services (Lipczynski *et al.*, 2013:127).

The fact that there is a high turnover amongst the board of directors at Eskom is one indication of a compromised corporate governance system. In their study of Chief Executive Officer's (CEO's) compensation and the performance of SOEs in South Africa, Ngwenya and Khumalo (2012) note that there is a negative relationship between CEO compensation and SOE performance. They also found that in 2011, the salaries of Eskom's executives increased by 109%. This is surely a large contributor

to Eskom's debt, as these salaries could be revised down and the surplus invested into working capital, assets or even paying off some its interest-bearing debt.

According to Price Waterhouse Coopers (PWC) (2015:31), the SOEs of the future need to have the following four properties in order to enhance corporate governance. These properties are 1) active ownership and 2) management by government, but with 3) a clear mission and vision, as well as 4) transparency and accountability. These properties should be internally managed with efficient processes and services; and should be a strategic playground for growth and development.

In a study of corporate governance in SOEs in Southern Africa, Balbuena (2014) has the same a similar view to PWC, and she details six sub-sections to corporate governance which she views as challenges in SADC countries (South Africa, Swaziland, Lesotho, Zimbabwe, Mozambique and Mauritius).

They are as follows (Balbuena, 2014):

1. The legal and regulatory framework;
2. The role of the state acting as an owner;
3. The treatment of non-government shareholders and private participation in SOEs;
4. Relations with stakeholders, corporate ethics and anti-corruption;
5. Transparency, accountability and disclosure; and
6. SOE board practices.

2.9 PRIVATISATION: LESSONS FROM INTERNATIONAL UTILITIES

Privatisation has always been viewed as the best alternative to state ownership. This is because privatisation primarily reduces borrowing costs to the government. While SOEs are indeed a burden on the state, this section shows that full privatisation may not be the best solution. Therefore, the ownership and management of an SOE should be carefully thought out in order to avert the pitfalls such as job losses and increases in the electricity price, which occurred with the gas and electricity privatisation in the UK (Section 2.9.1) and the California electricity crisis in the USA (Section 2.9.2).

2.9.1 Gas and electricity privatisation in the UK

From 1948 until 1990, the UK had a monopoly supplier of electricity called the Central Electricity Generating Board (CEGB). It consisted of the generation and transmission

division with 12 area boards, locally known as municipalities, responsible for distribution (Newberry & Pollit, 1997). This structure is similar to that of Eskom. The UK's power industry also has a regulator, which is the Office of Gas and Electricity Markets (Ofgem) under the Gas Act of (1986), Electricity Act of (1998) and Utilities Act of (2000).

The way in which the market now works is through a power pool. Companies that generate electricity sell to the pool, while suppliers buy from it. However, the generation companies were soon abusing their market power by charging high prices to the pool, by making low-cost generation plants available and claiming they need emergency maintenance, hence the high prices (Varian, 2010; Pindyck & Rubinfeld, 2013).

In the 1980s, privatisation was a big policy instrument in the UK. Those years were also called 'Thatcher era', where the UK even had initial public offerings (IPOs) for the British Airways, Rolls-Royce, British Airports, as well as companies in the steel and water industries (Lypczynski *et al.*, 2013:708-709). The electricity industry was later privatised in 1989.

According to Bacon (1995), the key reason for privatisation was the belief that the market is more efficient. However, and perhaps a more realistic reason is that the government did not want the responsibility of subsidising SOEs. Another reason was the large receipts the state would receive from the private sector which would improve the UK's borrowing requirement (Bacon, 1995).

There were many positive effects of the reform, such as an increase in labour productivity, increased competition in the industry, consumers being able to choose their own suppliers, and substituting away from coal to gas, which is a 'cleaner' technology (Newberry & Pollit, 1997). However, there were also negative effects in that there was a great amount of job shedding, with 250 000 workers in the mining industry losing their jobs owing to the substitution away from coal towards gas. Another disadvantage of privatisation was that the private suppliers were charging exorbitant electricity prices.

2.9.2 California electricity crisis in the USA

The California electricity crisis occurred in 2001. For nearly a century, California's electricity industry was organised around three regulated private vertically integrated monopolies, namely, Pacific Gas & Electric (PG&E), Southern California Edison (SCE) and San Diego Gas & Electric Company (SDG &E) (Joskow, 2001:366). It is of great pertinence to recognise the length of time which these monopolies had been in operation and the fact that they were regulated. These are the characteristics of Eskom. The only difference is that in California, the regulatory responsibility was split between two entities, the first being the California Public Utilities Commission (CPUC), which regulates electricity prices, and other terms and conditions of retail service (Joskow, 2001:367). The second regulator was the Federal Energy Regulatory Commission (FERC), which was responsible for regulating the terms and conditions of the selling of power between utilities and the sales of unbundled transmission service required to support wholesale power transactions (Joskow, 2001).

After pressure from industrial customers to reduce electricity prices, the CPUC initiated a comprehensive review of the structure and performance of the California electricity supply industry in 1993. By April 1994, the CPUC released a report called the 'Blue Book', which was a radical reform programme. It is particularly intriguing that concerns about high prices led the CPUC to a complete reform, as opposed to perhaps smoothing electricity price increases over time. This course of action could have been easily attainable through extensive calculations by the regulators.

The reform programme was a disaster, as prices rose by 500% between the second half of 1999 and the second half of 2000 (Joskow, 2001). This speaks volumes about introducing elements of full reform, such as privatisation and the introduction of competition, in a monopolised market. One reason for the crisis was allowing the market to determine prices. At moderate and low demand periods, electricity prices were relatively close to marginal costs. However, when demand was high, it was clear that the market was clearing at prices far above the marginal cost of the most expensive generators in the region (Varian, 2010).

In addition to the already bleak picture, PG&E and SCE both became insolvent in January 2001, and stopped paying their power bills and other financial commitments (Joskow, 2001). This is because wholesale power prices rose dramatically, while retail

prices remain fixed and so the utilities were going at a loss. Eventually, the State of California had to step in and was forced to use state funds to purchase power from unregulated wholesale suppliers to avoid widespread blackouts (Joskow, 2001). To avoid further losses as a state, retail price increases of between 30 – 40% went into effect in June 2001 and it is likely that this will remain the case for quite a long time (Joskow, 2001).

2.10 CONCLUSION

An important conclusion to be drawn from this chapter is that government intervention can be detrimental to SOEs' operations and eventual financial stability. During apartheid, the biggest error that the government made in 1984 was to recommend that Eskom should not charge cost-reflective tariffs. This resulted in flat electricity tariffs across the 1990s, but bearing in mind that Eskom was operating with substantial debt. Another error made by the state in the democratic era was in the restructuring of the energy sector. The Energy White Paper issued in 1998 resulted in Eskom closing its generation building department in 2001 because they were informed that new electricity supply would come from the private sector.

This is by and large the reason why the government has had to channel significant amounts of money into Eskom's balance sheet through equity injections, state-guaranteed loans, and receipts from the global issuance of Eskom bonds. This is because the financial crisis at Eskom has been a long time coming from 1984. In both eras of Eskom's operations, the background shows that government should have a restricted role in the operations of an SOE, regardless of its share as the majority shareholder.

However, corporate governance issues cannot be ignored. Corruption at Eskom continues to make an already unstable SOE into a further financially crippled entity. This is where corporate governance plays a critical role, and where the appointment of board of directors should be far more independent. As for the challenge of Eskom continuing to be a fiscal risk, the National Treasury needs to consider fiscal consolidation as one of the ways to resolve the entity's debt challenge. Otherwise, it has to consider privatisation.

However, privatisation of the electricity industry in the UK and USA provides some lessons for Eskom. The main positive effects of privatisation are increased competition in the industry, a broader consumer choice of suppliers, and switching to more environmentally friendly generation (gas in the UK). But more importantly, the negative effects were job losses, mainly for the UK coal mining industry as well as high electricity prices in both countries.

Given all the sections contained in this chapter, it is up to the state to choose the way forward for Eskom, but the background and literature show that fiscal consolidation is effective, while full privatisation of the electricity industry can be detrimental to employment and consumer prices.

CHAPTER 3: THEORETICAL AND EMPIRICAL LITERATURE

3.1 INTRODUCTION

This chapter is critical in order to highlight the theoretical foundation of the study's empirical analysis. The study seeks to investigate the relationship between government debt and the financial performance of Eskom, and as such, is a macro – micro model. To the author's best knowledge, studies in economics on this relationship are very scant. Hence, there is difficulty in locating a specific economic theory which applies to the variables contained in the empirical models. As a result, several theories are used to justify the variables in this study.

Section 3.2 presents a theoretical discussion of the dependent variable, namely, government debt, by using the Keynesian theory of government debt, while Section 3.3 will discuss the corresponding empirical literature. Section 3.4 presents a discussion of the theoretical literature that explains the financial variables chosen as independent variables for the current study.

The theoretical literature is comprised of the neoclassical theory of the firm, the Modigliani and Miller paradigm, agency theory, stakeholder theory and the new institutional economics approach.

Section 3.5 discusses the positive and adverse effects of the financial performance of a state-owned enterprise. Section 3.6 unpacks the empirical literature that is related to an SOEs' financial performance. Section 3.7 concludes by reiterating that the current study has used several theories to test the relationship between government debt and the financial performance of Eskom.

3.2 THEORETICAL LITERATURE: GOVERNMENT DEBT

According to Buchanan (2008:1), "government debt is a legal obligation on the part of a government to make interest and/ or amortisation payments to holders of designated claims in accordance with a defined temporal schedule". Ward (1987:1) also makes mention of the fact that it is the difference between the total receipts of central government, local authorities, and public enterprises, considered in aggregate and

their total expenditure. One could also add that government debt is the accumulation of every year's budget deficit.

This section discusses the various aspects that are relevant to government debt and that are relevant to the current study.

3.2.1 Purpose of government debt

Keynes (1936) believed that the accumulation of government debt should only be used for public capital expenditure and to stabilise the economy as a form of decreasing unemployment. In the same vein, Tanzi (2016) supports this argument by noting that Keynes proposed that public borrowing should also have a short life span, since its primary use is to stabilise the economy in the short-term. Therefore, Keynes did not advocate for government debt to be used for government consumption or transfers, be they for social spending or even public entities. This narrative resonates with Svaljek (1997) who argues that government borrowing should not be used for balancing current accounts, inflation control, the growth of private investments, or even maintaining credibility as a state.

3.2.2 Approaches to government debt

There are mainly two approaches to government debt, namely, the normative approach and the positive approach. The sub-sections below will discuss these two general approaches to government debt.

3.2.2.1 Normative approach to government debt

The normative approach can be associated with the neoclassical school of thought. The main idea behind this approach is that the state is a benevolent social planner, and its only function is to provide greater flexibility for the government in the intertemporal balancing of government debt revenues and expenditures (Barro & Grilli, 1994). Barro's (1979) theory of the neutrality of debt is the underlying foundation of this approach. Neck and Getzner (2001) also call this theory the Barro's tax smoothing model or the equilibrium approach to fiscal policy.

Barro (1979) uses the Ricardian equivalence theorem to show that expansionary fiscal policy does not have an effect on aggregate demand. He claims that this theory holds because of his notion of tax smoothing or constant tax rates. This means that when the government increases its expenditure through debt financing, individuals have

myopic foresight, anticipate this budgetary change and act accordingly. For instance, if the government decreases taxes by borrowing, individuals will anticipate higher taxes in the future and so will not engage in any consumption spending. This implies that there will be no effect on aggregate demand, interest rates, wealth, or even capital formation (Svaljek, 1997).

Other economists, such as Stiglitz (2015), have even viewed government spending as a growth factor because they believe large and sustained fiscal injections are justified when the growth rate falls below what they believe should be the long-term trend.

On the contrary, Brauning (2005) actually notes that there is a negative relationship between government debt and economic growth. Mncube and Broxvia (2015) use the debt-stabilising primary balance framework in supporting Stiglitz (2015) because they view debt management as a tool for enhancing economic growth and growth enhancing investments. This means that they also use the balanced budget approach to government debt, where deficits are always undesirable because they crowd out private investment; hence, the need for stimulus packages when the growth rate is below the perceived potential growth rate. It could also be said that the balanced budget approach views stimulus packages as necessary when the government experiences budget deficits.

3.2.2.2 *Positive approach to government debt*

Over the past few decades, there has been a growing trend of government debt accumulation, despite the fact that many governments do not need to borrow (Tanzi, 2017).

The accumulation of government debt is attractive because unlike taxes, it requires little coercion, no administration, and is readily available to repay over an extremely long period of time. However, evidence from Buchanan (2008), Tanzi (2016) and Hyman (2011) suggests that the burden of public debt is shifted to future generations in the form of higher taxes which will be used to pay the interest on the current accumulated debt. Thus, the study refutes the Ricardian equivalence theorem and Barro's (1979) tax smoothing model. This is because in reality, every economic action of an individual, business or government, has an effect on the economy.

Government debt is a dependent variable in this study to show that the neutrality of debt does not hold. Economic theory supports the stance of the study through Keynes' aggregate demand model as illustrated in Figure 3.1 below.

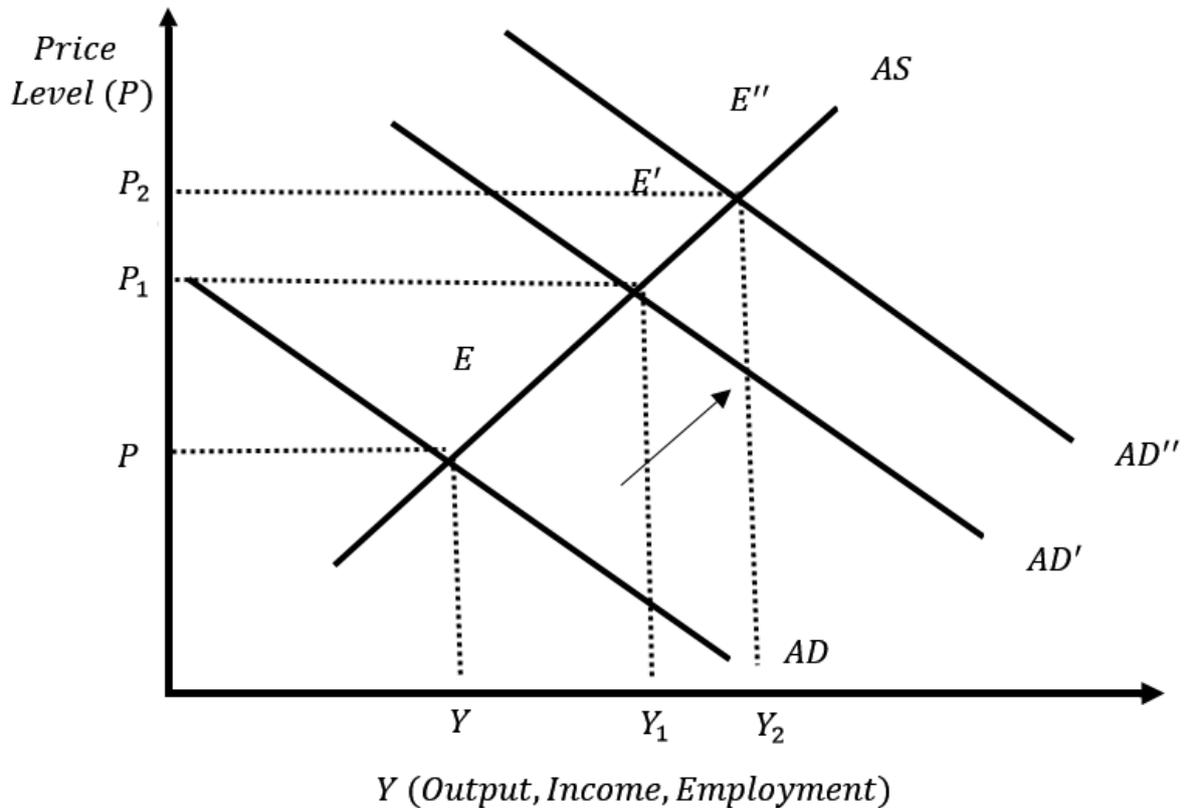


Figure 3.1: Aggregate Demand-Aggregate Supply Model (AD-AS model)

Source: Adapted from Snowdon & Vane (2005), Blanchard & Johnson (2014)

Keynes Demand Function:

AD= Consumption + Investment + Government Spending + (Exports – Imports)

$$Y = C + I + G + (X-M) \dots \dots \dots (3.1)$$

$$GDP = C + I + G + (X-M) \dots \dots \dots (3.2)$$

Figure 3.1 above shows the AD-AS model. Its assumption is that all variables are fixed, except government spending. Therefore, all else being equal, the raising of government debt can be used to increase government spending.

Initially, the economy is at equilibrium point E, at output level Y, and price level P. An increase in government spending will cause the aggregate demand curve to shift outward to the right, from AD to AD'. This puts the economy at the new equilibrium

point E' , and output increases from point Y to Y_1 while the price level also increases from point P to P_1 (Blanchard & Johnson, 2014).

This shows that government borrowing does indeed have an effect on aggregate demand and inflation, which is the general increase in the price level. An increase in aggregate demand requires more labour. As workers are employed and earn an income, they spend part of it and save the other. This contributes to wealth and consumption. Therefore, using this model, the study refutes the normative approach to government debt.

3.2.3 Effects of government debt

This section discusses the effects of government debt in terms of the positive and negative effects of government debt, and deficit financing.

3.2.3.1 Positive effects of government debt

If the borrowing described in the previous section is invested in capital expenditure, there will be an increase in output by firms (Peston, 1987:1). Owing to a higher level of production, firms will employ more labour, and this will increase the aggregate income in the economy (Perry, 1987:1). Owing to Keynes' multiplier effect, when the newly employed labour spend some of their income, there is a further increase in aggregate demand, although not by the same proportion. This causes the demand curve to shift further out from AD' prime to AD'' .

This effect on aggregate demand supports the study by Alesina and Tabellini (1990) who assert that debt accumulation can serve as a way of redistributing income over time and across generations. This redistribution of income can reduce the deadweight loss associated with taxes which come from the provision of public goods and services.

3.2.3.2 Adverse effects of government debt

When it comes to the effects of government debt on the price level, Keynes' assertion that borrowing should only be used for capital expenditure, or as a stabilisation policy, becomes apparent (Snowdon & Vane, 2005). An increase in government spending creates inflationary pressures on the economy. This eats away at consumers' purchasing power which, *ceteris parabus*, can lead to lower economic growth because of a decrease in consumption (Blanchard, 2014). Therefore, this is one of the reasons

why Keynes emphasised that borrowing should never be used for transfers or general government consumption, because over time the inflationary pressures undermine the objective of the initial increase in government spending.

The effects of expansionary fiscal policy are certainly positive for economic growth, output and employment. However, too much borrowing to expand government spending has adverse effects. This is because there is a tendency for the state to spend more than it receives. This is mostly because of high levels of social spending that states engage in and at some point, and that causes government spending to outstrip its revenue (Hyman, 2011; Black *et al.*, 2015). In such instances, the government usually engages in activities of deficit financing.

3.2.3.3 Deficit financing

The main way in which deficit financing or functional finance occurs is by borrowing from credit markets. The government does this by increasing its demand for loanable funds. This increase in the supply of loanable funds causes the interest rate to increase, which decreases the quantity of loanable funds available (Parkin *et al.*, 2012:530). In addition, this is detrimental to households and firms who would want to acquire any form of durable goods because the interest rate on the respective loanable funds would be too high (Hyman, 2011:500).

The effect of debt financing is what is known as the debt burden. This is the redistributive effect of debt financing (Hyman, 2011:515). Debt financing causes a decrease in the level of investment because of the higher interest rates on loanable funds. This has the capacity to increase unemployment, since the decrease in the volume of investment implies less output and less need for labour (Hyman, 2011:499).

Although debt financing implies lower tax in the current period, in future there will be an increase in future taxes that are needed to cover the interest payments of the accumulated debt. This shifts the debt burden to future generations who will have lower standards of living most probably owing to higher inflation as well.

3.3 EMPIRICAL LITERATURE: GOVERNMENT DEBT

Wheeler (1999) conducted a study on the macroeconomic impacts of government debt in the USA during the 1980s and 1990s. This was of particular interest because the USA had amassed a large proportion of government debt at the time. The study was conducted through the use of a Vector Autoregressive (VAR) model to derive variance decompositions and impulse response functions.

Wheeler's (1999) study tested the Barrow's REH (1979) by examining the impact of government debt on output, price levels and interest rates. He used the following variables in his model: exogenous elements of fiscal policy (G), is federal debt (D), money stock measured as a real variable (M2), industrial production (Y), and the consumer index, P (Harris, 1995; Lütkepohl, 2006; Lütkepohl & Poskitt, 1991). He found that the Ricardian equivalence is at odds with his results, since government debt proved to have a negative impact on macroeconomic activity.

The scholars, Sunge, Mufandaedza and Matsvai (2015) found that the REH does not hold for Zimbabwe for the period from 1980 to 2013. The variables used in their study were private consumption, GDP, government expenditure, tax revenue, total government debt and interest payments. They determined this by using an Error Correction Model (ECM) in an autoregressive distributed lag (ARDL) bounds testing approach. Using the same methodology, Osodiuru, Odo, Ugwuoke and Chikwendu (2018) also conducted a study to test the REH in Nigeria from 1986 to 2015. They found that a long run relationship does exist between private consumption and GDP, government expenditure, tax revenue, total government debt and interest payments.

Hayo and Neumier (2016) used a logit model to find the validity of the REH. They did this by conducting a representative sample survey of 2,000 participants in Germany. They were asked whether they made significant changes to their consumption and behaviour patterns after an increase in government debt for the period from 2008 to 2012. In general, they found that the equivalence theory does not hold. However, there are a significant number of scholars who have found empirical support for the Ricardian equivalence. Other studies which supported the REH, using the VAR model, during the 1980s and 1990s include those by Dwyer (1982), Plosser (1982), Fackler and McMillin (1989), and Darrat (1989, 1990).

There are also recent studies which support the REH. Mosikari and Eita (2017) tested the theory in the Kingdom of Lesotho for two sample periods, namely, 1980 to 2014 and 1988 to 2014, using the ARDL cointegration approach. In this approach they tested the relationship between household consumption, government debt, government expenditure, GDP per capita, population growth and inflation. They found that the REH holds for Lesotho's economy, thus fiscal policy is an ineffective tool to stabilise the economy.

Similarly, Nkalu, Richardson and Nwosu (2016) also conducted a test of the REH in Ghana and Nigeria during the period from 1970 to 2013. They used the Seemingly Unrelated Regressions method and Two-Stage Least Squares. They established a long run cointegrating relationship between interest rates, government expenditure, budget deficit, money supply and inflation. Unlike the finding of Osodiuru *et al.* (2018), they concluded that the REH holds in Ghana and Nigeria.

Magazzino (2017) tested the REH using a VAR model in a panel study of the Association of Southeast Asian Nations (ASEAN) and Asia-Pacific Economic Cooperation (APEC) countries for the period 1980 to 2013. He used this model to test the relationship between the trade balance and government budget. His study was ambiguous, since he found that the hypothesis doesn't hold for 10 countries out of the 31 economies which make up the ASEAN and APEC.

This empirical literature review has argued that although many studies support the REH, government debt generally has adverse effects on macroeconomic activity. Most of the studies used the following variables: government debt, GDP, government expenditure, tax revenue, consumption, output, money stock, interest rates and inflation.

However, studies by Wheeler (1999), Hayo and Neumier (2016), Sunge *et al.* (2015), as well as Osodiuru *et al.* (2018), support this study in its assertion that debt financing and general government debt are detrimental to the average citizen. This is because the citizen is the one who faces high interest rates after government's debt financing decreases the supply of loanable funds. The citizen also has to repay the debt in the form of increased future taxes. All of these factors lead to poor living standards for current and future generations. Table 3.1 (on the next page) presents a summary of the empirical literature on government debt.

Table 3.1: Summary of empirical literature on government debt

Study	Sample	Methodology	Findings
Wheeler (1999)	United States; 1980 – 1995	VAR: Impulse Response Functions and Variance Decomposition Analysis	The study refutes the REH
Hayo & Neumier (2016)	Representative sample survey of 2,000 participants in Germany	Logit model	The survey found that no significant changes were made to participants' consumption and behaviour patterns after an increase in government debt from 2008 – 2012. The study refutes the REH
Sunge, Mufandaedza & Matsvai (2015)	Zimbabwe: 1980 – 2013	Error Correction Model in an autoregressive distributed lag (ARDL) bounds testing approach	The study refutes the REH
Osodiuru <i>et al.</i> (2018)	Nigeria :1986 – 2015	Error Correction Model in an autoregressive distributed lag (ARDL) bounds testing approach	The study refutes the REH
Dwyer (1982), Plosser (1982), Fackler & McMillin (1989), Darrat (1989, 1990).	United States: 1980 – 1990	VAR: Impulse Response Functions and Variance Decomposition Analysis	The studies support the REH
Mosikari & Eita (2017)	Kingdom of Lesotho: 1980–2014 and 1988–2014	ARDL cointegration approach	The study supports the REH
Nkalu, Richardson & Nwosu (2016)	Ghana and Nigeria: 1970 – 2013	Seemingly Unrelated Regressions and Two-Stage Least Squares method	The study supports the REH

Study	Sample	Methodology	Findings
Magazzino (2017)	ASEAN and APEC: 1980 - 2013	VAR model in a panel study	The results are ambiguous, the study found that REH does not hold for 10 countries out of the 31 economies which make up the ASEAN and APEC

3.4 THEORETICAL LITERATURE: FINANCIAL PERFORMANCE OF STATE-OWNED ENTERPRISES

According to Broer (2012), despite recent progress, equations which describe business behaviour are still a shortcoming in macroeconomic models. As such, this study is unique in that it draws from several theories as foundations of its empirical models. Sections 3.2 and 3.3 have discussed the theoretical and empirical literature on the dependent variable, which is government debt. Sections 3.4, 3.5 and 3.6 will discuss the theoretical and empirical literature related to the independent variables in the study. These variables are associated with the financial performance of Eskom and they are Eskom's revenue, the electricity price, Eskom's staff numbers, its current ratio, as well as its debt-to-assets ratio.

3.4.1 Neoclassical theory of the firm

While Eskom may be a state-owned enterprise, it is a firm first. Thus, it is important to consider the neoclassical theory of the firm as the first point of reference. This is because the theory of the firm contains the basics of how firms carry out their production decisions.

Capital and labour are often used as the basic inputs into production, and so they are a measure of productivity. The measures of efficiency and profitability used in the theory include, but are not limited to, the price and revenue. The study uses these two measures of productivity as two of its independent variables.

Figure 3.2 below presents a graphical illustration of the microeconomics production function.

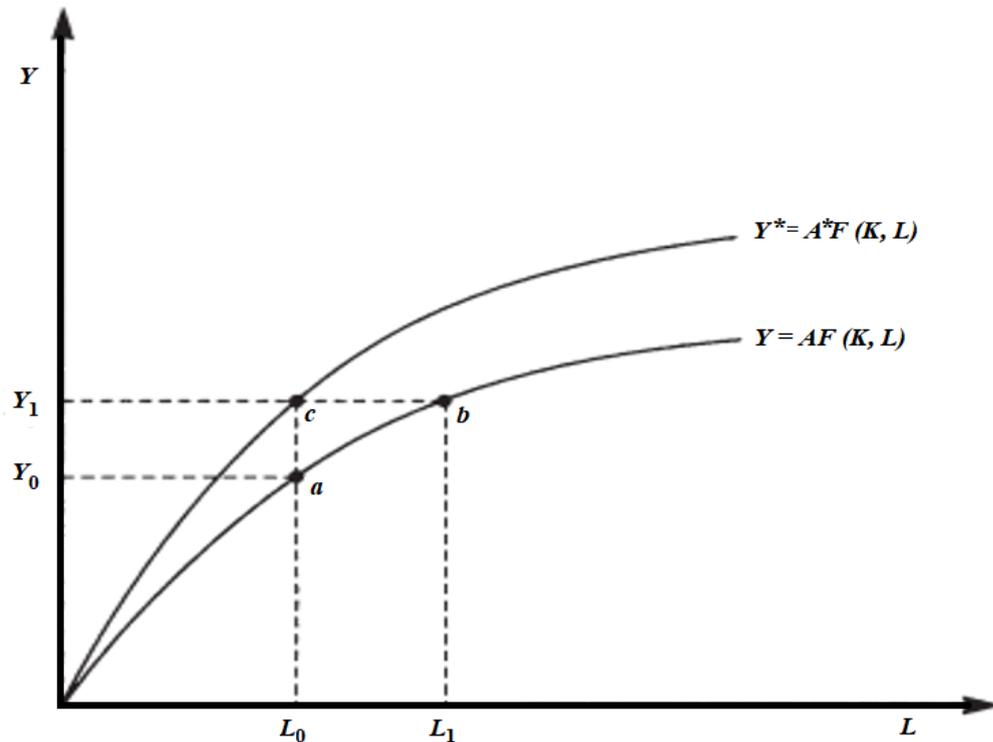


Figure 3.2: Microeconomics production function

Source: Snowdon & Vane (2005)

Where:

Y = output

K = capital

L = labour

Figure 3.2 above is a production function of a typical firm which shows the different combinations of input needed to produce output. In this case, $Y = AF(K, L)$, where A is technology which is assumed to be fixed because innovation occurs over long periods of time. Therefore, the only two inputs to production considered in this figure, are K which is capital and L which is labour. If output is initially at point a, where output is at Y_0 and labour at L_0 , an increase in staff numbers, from L_0 to L_1 , increases output from Y_0 to Y_1 (Snowdon & Vane, 2005).

The current study uses staff numbers as a measure of productivity at Eskom. This is due to the fact that Eskom's working capital was found to be negative when calculated for the entire sample period 1985 - 2017. However, in theory, the impact of an increase in capital will have the same effect on output. The production function shifts upward from Y to Y^* when there is technological change.

Central to the narrative of the theory of the firm is the notion of efficiency (Pindyck & Rubinfeld, 2013:610). Economic theory makes a distinction between two types of efficiencies, namely, technical and allocative:

- With technical efficiency, the focus is on the least-cost solution for a given output, where price is equal to the marginal cost: $= MC$, and marginal revenue is equal to marginal cost ($MR = MC$) (Pindyck & Rubinfeld, 2013:612).
- Allocative efficiency, however, requires both technical efficiency and a focus on the socially desirable output.

A firm produces a socially desirable output when resources are used over a particular time period in such a way as to make it impossible to improve the well-being of one person without reducing the wellbeing of another.

According to Pindyck and Rubinfeld (2013), the following are the conditions of a perfect market:

- Firms are not able to make abnormal profits or revenue because they charge the price that is equal to the cost of producing an extra unit of a good. By implication there is no exploitation of consumers.
- Firms in perfect markets become price-takers, which means that they take the price as given, owing to the large competition from many other firms (Pindyck & Rubinfeld, 2013:280).
- There is free entry and exit in the market, and usually, product homogeneity. As such, there is no information asymmetry (Snowdon & Vane, 2005).
- The price reflects perfect information about the cost of production, markets are complete, prices are uniform, and known to both buyers and sellers across all markets, and all markets automatically adjust in the short term.

3.4.1.1 The monopoly

A monopoly is a firm which has dominance in the market, and which is also known as concentration (Lipczynski *et al.*, 2003). Eskom is one such firm, since it owns the generation, transmission and distribution across the country, sharing only a small percentage of the distribution of electricity with municipalities (Eberhard, 2004).

As such, monopolies are generally able to abuse their dominance by producing less, while charging a higher price for a given output. According to Varian (2010), the following scenarios are associated with a monopoly:

- Firms are able to make abnormal profits and higher revenue than firms in perfect competition;
- Monopolies are able to set their own prices since they are not affected by any competition;
- There are high barriers to entry since monopolies are usually able to afford expensive means of production and have already captured the market; and
- A monopolist's price is not cost-reflective since there could be a high mark-up on cost as a result of its abuse of dominance.

Figure 3.3 below illustrates the long run output decision of a monopoly.

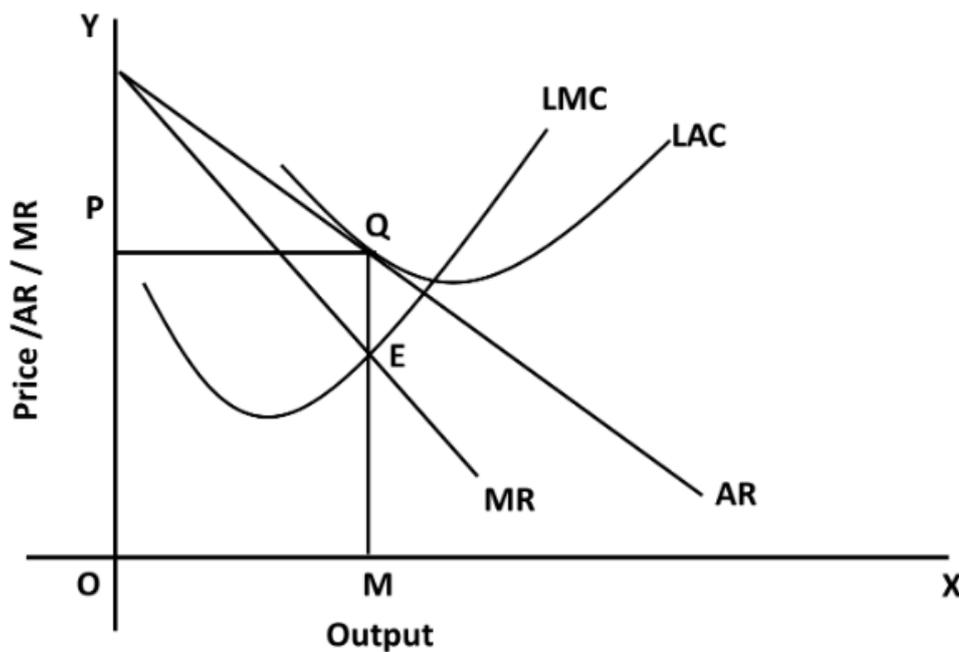


Figure 3.3: Long run output decision of a monopoly

Source: Varian (2010)

Figure 3.3 above displays the aforementioned characteristics of a monopoly, where:

P = price

LMC = Long run marginal cost

LAC = Long run average cost

MR = Marginal revenue

AR = Average revenue

The AR curve is also the market demand curve. If a monopolist produces at Q , they produce at a price P , which is higher than the long run marginal cost curve. As such, a monopolist makes abnormal profits as their price of a unit is greater than its marginal cost (Varian, 2010).

3.4.1.2 Regulation of monopolies

As previously stated, utility industries often have regulators, and the National Regulator of South Africa (NERSA) is the regulator of the power sector in South Africa. The most pertinent duty of a regulator is to investigate any unfair practices by firms. Unfair practices include barriers to entry, abnormal profits and prices that are not cost-reflective (Varian, 2010).

It is important to emphasise that the most significant violation of monopolies to competitive practices is the rent-seeking approach to its price. This is a challenge, since efficient pricing is critical to any industry's competitive structure and overall fairness to consumers (Briceño-Garmendia & Shkaratan, 2011).

Other mandates of a regulator include assessments of whether power producers' prices are efficient or not, and whether consumers derive social benefit from their electricity purchases (Alexander & Harris, 2005).

Monopolies are aware that they have market power, and consumers are forced to subscribe to their product, even when it is not equitable to do so. As such, the regulation of a monopoly that is a state-owned enterprise has to be even stricter, as their purpose is not only profit but also social equity (Black *et al.*, 2015).

Regulators are also important to address firms' costs which may be unintentional. Coase (1960) has identified the problem of social cost which can occur with a firm's production decisions. The social costs associated with coal-generated electricity include negative externalities, such as pollution and carbon emissions.

As of 31 July 2003, South Africa became one of the countries which adhere to the Kyoto Protocol, which is an international treaty that extends the 1992 United Nations Framework Convention on Climate Change (Department of Energy, 2019). The main aim is the reduction of carbon emissions amongst the country members. Public finance literature suggests four ways in which this can be achieved, namely, through corrective

taxes, emissions standards, control and command policies, as well as the trading of pollution rights amongst emitting firms (Hyman, 2014).

However, it is important to note that, while these methods may be effective in trying to curb the effects of carbon emission, there are also adverse effects. Firstly, South Africa is well endowed with coal, and so this is a competitive advantage in electricity generation. Also, Pereira Freitas and Pereira da Silva (2013) have found a strongly significant dynamic passthrough of carbon prices into electricity prices. In their study, they considered the Portuguese electricity system which includes gas and coal. Therefore, NERSA has to consider the aforementioned factors in its regulation practices.

3.4.2 Risk Management Theory

According to Pritchard (2014), risk is inherent in any business decision, hence risk management is an important strategy for any organisation, whether private or public. It is the failure of companies to manage risk that results in their poor performance, and as such, Eskom is no different.

The literature contains examples of both financial and economic theories which relate to the financial risk management of a company. For the purposes of the current study, the Modigliani and Miller paradigm, agency theory, stakeholder theory and new institutional economics will be discussed in the sub-sections below.

3.4.2.1 Modigliani – Miller paradigm

Central to corporate risk management is the Modigliani – Miller paradigm, which posits the notion that the value of a firm is independent of its financial structure (Modigliani & Miller, 1958). According to this paradigm, as long as a company is hedging, its corporate risk management enables it to have a higher debt capacity (Modigliani & Miller 1958); lower expected costs of bankruptcy (Smith & Stulz 1985); comparative advantage in terms of information asymmetries, as well as a greater ability to secure internal financing (Geczy, Minton & Schrand, 1997).

Of the few scholars that have investigated the Modigliani and Miller (1958) paradigm, Faff and Nguyen (2002), Graham and Rogers (2002), as well as Guay (1999), found that hedging enables higher debt capacity. Eskom debt is one of the independent variables in the study. The variable is of great interest, since Eskom's debt has a direct

relationship with that of government's. Guay (1999) and Geczy *et al.* (1997) verified that hedging results in an increase in internal financing, while Faff and Nguyen (2002), as well as Mian (1996) refuted this.

There is a plethora of financial literature that analyses the financial performance of different types of firms, such as SOEs, private firms and mixed enterprises. Tian and Estrin (2007) conducted a study on Chinese publicly listed companies, specifically one in which government has a significant share ownership. They used an Ordinary Least Squares (OLS) and an Arellano-Bond General Method of Moments (GMM) regression. The study found that debt financing causes inefficiency in publicly listed Chinese companies. This conclusion was reached by way of modelling financial leverage ratios, managerial costs and the administrative costs of the company.

The Modigliani Miller paradigm is highly impactful when it is applied to Eskom as a company only, and not as an SOE. Eskom's hedging instruments include financial trading assets, insurance investments, derivatives held for risk management, and embedded derivatives (Eskom Annual Report 2019). The derivatives held for risk management are equal to R19,538 million, and yet their internal financing through debt securities and borrowings for 2019 are a mammoth R440,610 million. Since Eskom has high debt levels, it is important to assess its solvency and liquidity. This is why the current study chose the current ratio and debt-to-assets ratio as variables in the study.

The Modigliani and Miller (1958) paradigm has presented a risk management theory which is the foundation of corporate finance. However it has also resulted in adverse effects on companies' financial performance. This can be seen from the aforementioned financials at Eskom which are related to this paradigm.

However, Tufano's (1996) study found no evidence of the Modigliani and Miller paradigm (1958), and focuses more on managerial theories as an influence on corporate risk management theory. These managerial theories include the agency theory, stakeholder theory and the new institutional economics approach, as discussed below.

3.4.2.2 Agency Theory

The principal-agent relationship is a result of the modern firm's separation of ownership and control between the shareholder and the manager (Lipczynski *et al.* 2013). The agency theory is now the framework through which this relationship is

analysed. Agency costs to the company occur when there are information asymmetries between the shareholder and manager. Managers are prone to being self-interested and maximise their own utility at the expense of the company. Thus, managerial attitudes can have a significant impact on risk management (Smith & Stulz 1985).

In the case of an SOE, the majority shareholder of the company is the government, while senior management, such as the Chief Executive Officer, is the manager. Managers often take advantage of the fact that remuneration is not dependent on the organisation's performance due to low pressure from the state (Lipczynski *et al.*, 2013). As a result, they do not engage in revenue or sales maximisation or even growth maximisation (Baumol, 1959; Lipczynski *et al.*, 2013:92).

As such, one of the independent variables of the study is Eskom revenue to investigate the role of the agency theory. The electricity price is closely tied to sales maximisation, which is another reason why it was included as an independent variable in this study.

3.4.2.3 Stakeholder Theory

One of the earliest works of Friedman (1984) is the stakeholder theory. It is a managerial theory that is centred around the organisation and the balancing of the interests of its various stakeholders. Friedman (2006) as well as Harrison and Wicks, (2013) calls stakeholders the groups of people without which the organisation would not exist. The main types of stakeholders include shareholders, customers and employees. Klimczak (2006) has found that stakeholders are highly sensitive to costs of financial distress and bankruptcy.

The two stakeholders that are highly sensitive to the aforementioned costs at Eskom are the state and all other users of electricity. The state, because it has to constantly bail out the utility, and the users of electricity at the business and household level because of continual price increases.

3.4.2.4 New Institutional Economics (NIE)

Williamson (1998) is at the forefront of new institutional economics. This school of economic thought focuses on governance processes, and deduces that socio-economic institutions are involved in guiding these processes. NIE predicts that financial performance may be determined by institutions or accepted practices within

a market or industry. Such practices include remuneration that is independent of performance, as well as constant increases in the electricity price.

Although there are scant empirical studies related to NIE, it has a stronger element of corporate governance practices than practically managing financial performance.

3.5 THEORETICAL LITERATURE ON FINANCIAL PERFORMANCE

This section presents an evaluation of the theoretical literature regarding the positive and negative aspects of financial performance.

3.5.1 Positive aspects of financial performance

The Modigliani-Miller paradigm emphasises the importance of hedging in order to minimise risk, thereby encouraging companies to use their hedging as an indicator of company value. The positive aspect of this paradigm is that it is practical and can be easily implemented.

According to the agency theory, information asymmetries result in miscommunication between the principal and agent. Thus the theory is helpful for companies to identify processes through the enhanced communication between the two agents. By doing so, the company implements an important strategy for increasing its company value.

The stakeholder theory is useful because it has a high explanatory power in that it focuses specifically on the equilibrium of stakeholder interests as the main determinant of corporate policy. New institutional economics is instrumental in understanding risk management in SOEs because it emphasises how the theory focuses on governance processes. This is a strong driving factor around the financial crisis at Eskom, and has been for a long period of time.

Ironically, when a monopoly is performing well or is profitable, it implies they are creating a social cost or deadweight loss in society (Hyman, 2011). This is because a monopoly is able to sell at a higher price for a lower quantity. This is the case with the purchase of electricity from Eskom, where a purchase of electricity can give you less than half of the rand value in kilowatts.

3.5.2 Negative aspects of financial performance theoretical literature

The Modigliani and Miller (MM) paradigm can have a detrimental impact on the company value in the long run. They encourage taking on high debt capacity, securing

internal financing, and using information asymmetry as a competitive advantage. This encourages managers to engage in risky financing and borrowing too heavily (Lipczynski *et al.*, 2013:90).

If Eskom were not the backbone of the economy, this theory would not be as detrimental to society. As with the adverse effects of government debt, Eskom's debt and high internal financing have an equally negative impact on citizens. Internal financing refers to the ability of Eskom to gain access to funds. Their financial statements indicate that their internal financing includes state-guaranteed loans; commercial paper; export credit facilities and even funds from credit export agencies (Eskom Financial Statements, 2019; Thorne, 2018).

Eskom's debt affects the standard of living of South African citizens because a large proportion of their income has to be spent on electricity. The paradigm says a company that hedges can also have information asymmetry competitive advantage. This refers to the constant increases in electricity tariffs whose cost-pricing formula is not made public to ordinary citizens.

However, not only do energy users have to bear the brunt of constantly increasing electricity tariffs, but they are also exposed to load shedding and blackouts. Gigler and McMillain (2018) found a significantly negative relationship between load shedding and productivity. Therefore, the most adverse effect of the Modigliani and Miller paradigm is its disregard for corporate governance and managerial discretion before taking on exceptionally high debt and securing internal finance.

The other theories found in the literature do not have any negative aspects since they attempt to bolster efficient management practices.

3.6 EMPIRICAL LITERATURE: FINANCIAL PERFORMANCE

While the neoclassical theory of the firm is the cornerstone of economic theory, it is highly abstract and has not undergone many empirical tests (Estola, 2014). Similarly, in the field of corporate risk management, not many theories support the concept of financial performance through empirical analysis and data. Hence, many of the empirical studies in this section will measure financial performance from a practical accounting-based perspective.

Klimczak (2007) conducted a panel study of 150 non-financial Polish companies listed on the Warsaw Stock Exchange from 2001 to 2005. He conducted his study by using several methods, including Hotelling's test (Mardia, 1975) for difference of vector means; ANOVA models, logit regressions, as well as Classification and Regression Trees (CART). In order to maintain comparability with previous studies, Klimczak (2007) decided to use a hedging proxy as the dependent variable to measure financial performance. This is in accordance with the Modigliani and Miller paradigm. Overall, Klimczak's (2007) empirical results showed that although the Modigliani and Miller paradigm encourages high debt levels, from an agency perspective, an increase in gearing levels should only be done if there is low equity or low assets.

The independent variables of interest in Klimczak's study were sales (revenue), economies of scale, and government share in equity of greater than 5%. The two latter variables are useful to bolster the current study because economies of scale give a company a competitive advantage (Lypczynski *et al.*, 2013). The share of equity which a government has in a company is also important in managing the principal-agent relationship which is founded on the agency theory (Smith & Stulz, 1985).

Empirically, the new institutional economics approach found that the role of trends, ownership, and the industries in which companies find themselves have a significant influence on financial performance (Klimczak, 2007). Empirical results obtained from testing the stakeholder theory found that the Information Technology (IT) and services sectors showed more interest in risk management than SOEs or public companies did.

Alshatti's (2015) study is one of the first few theories which quantify the financial performance of a company by using credit utilisation ratios from financial statements. The study by Gurbuz, Aybars and Yesilyurt (2016) also used an accounting-based measure of financial performance, but theirs was through the use of EBITDA (earnings before interest tax, depreciation and amortisation). They used a panel data analysis of BRIC public firms between 2004 and 2013. The EBITDA was their dependent variable, and their independent variable was leverage, which is the debt-to-assets ratio.

A study by Wang (2002) included return on assets (ROA) and return on equity (ROE) as dependent variables to measure financial performance. He did this in two separate OLS models of publicly listed firms on the Taiwan stock exchange during the period

from 2002 to 2007. A company's return on assets is related to the debt-to-assets ratio, since it measures the profitability of a company's assets. As such, the debt-to-assets ratio is of interest to the current study and has been included as an independent variable.

Odaló (2016) identified liquidity, as measured by the current ratio, as an important determinant of financial performance, and it is another variable of interest to the current study. Company size, which is measured by staff numbers in the study, was also used as a variable of interest in Odaló's (2016) study. Drawing from data found in financial statements, he conducted a study on the effect of liquidity and company size on the financial performance of listed agricultural companies listed on the Nairobi Security Exchange from 2003 to 2013. The study was conducted using a pooled OLS model.

Table 3.2 (on the next page) presents a summary of the empirical literature on financial performance.

Table 3.2: Summary of empirical literature on financial performance

Study	Sample	Measure of Financial Performance (FP)	Determinant of Financial Performance (FP)	Methodology	Findings
Klimczak (2007)	150 non-financial Polish companies on the Warsaw Stock Exchange: 2001 to 2005.	Hedging	Revenue, competitive information asymmetry (price), economies of scale and government share in equity of greater than 5%.	Panel study, Hotelling's test, ANOVA model, logit, Classification Regression Trees (CART).	Modigliani-Miller (1958): Positive relationship between revenue and FP. Positive relationship between competitive information asymmetry (price) and FP. Positive relationship between government share in equity and FP.
Gurbuz, Aybars & Yesilyurt (2016)	132 BRIC country firms, 2003 -2014	EBITDA	Leverage (debt-to assets ratio)	Panel data analysis	Agency Theory: High leverage has a negative effect on FP.
Wang (2002)	Publicly listed firms, Taiwan Stock Exchange, 2002 - 2007	Return on Assets (ROA), Return on Equity (ROE)	Leverage (debt-to assets ratio)	Two OLS regression models	Agency Theory: High leverage has a negative effect on FP.
Yazdanfar & Öhman (2014)	15,897 Swedish SMEs operating in five industry sectors: 2009-2012 period	Profitability (ROA)	Debt (short term and long term)	three-stage least squares (3SLS) cross sectional study	Agency Theory: Debt has a negative impact on FP.
Odalo (2016)	Listed agricultural companies in Nairobi Security Exchange from 2003 to 2013	ROA, ROE	Liquidity (current ratio), company size (staff numbers)	Pooled OLS model.	Agency Theory: There is a positive relationship between liquidity and FP.

3.7 CONCLUSION

This chapter discussed the theoretical and empirical literature related to government debt. The Keynesian theory on government debt asserts that government borrowing should not be used to support public entities. Barro's (1979) Ricardian Equivalence Hypothesis (REH) was refuted by showing that government borrowing has adverse effects on the economy. The empirical literature on government debt showed a strong preference towards the REH, with scholars from different countries, using different methodologies but similar variables.

The chapter also discussed the theoretical and empirical literature related to a company's financial performance. The neoclassical theory of the firm was at the core of understanding the behaviour of a monopoly, while the Modigliani and Miller paradigm offered the premise of corporate risk management theory. The paradigm advocates for high debt levels as long as a company is hedging. The agency theory, stakeholder theory and new institutional economics approach were discussed as the managerial theories and strategies to bolster a company's financial performance.

The independent variables of the current study, namely, leverage, liquidity, revenue or sales, with the resultant price, showed to be significant determinants of financial performance. The company size, which can be a proxy for staff numbers, was also a determinant of a company's financial performance. Overall, this chapter provided a theoretical foundation of how Eskom's debt has an adverse effect on government debt, the citizens, business, and the economy as a whole.

CHAPTER 4: METHODOLOGY

4.1 INTRODUCTION

The purpose of this chapter is to outline the estimation techniques which were used to generate the empirical results for this study. Section 4.2 starts by detailing the variables and the data sources. Section 4.3 presents a brief discussion of descriptive statistics, while Section 4.4 discusses the empirical techniques where stationarity and unit roots will be outlined. Section 4.5 outlines the estimation techniques of the VAR model, including Impulse Response Functions and Forecast Error Variance Decomposition Analysis. Section 4.6 discusses co-integration and the Error Correlation Model (ECM), using Engle and Granger's two-step model. Section 4.7 outlines the post-estimation diagnostic tests which were used on the ECM, while Section 4.8 concludes the chapter.

4.2 DATA SOURCES

Table 4.1 presents a list of the variables included in the current study and the sources of the data obtained for the study.

Table 4.1: List of variables

Variable	Description	Measurement	Source / Calculation	Variables in Logarithms
Government Debt (GD)	Total gross loan debt: foreign bonds	ZAR million	Quantec Easy Data	LGD
Eskom Debt (ED)	Eskom Debt: Non-Current Liabilities + Current Liabilities	ZAR million	Eskom Financial Statements (1985-2017)	LED
Revenue (REV)	Income a business receives from the sale of goods and services to consumers	ZAR million	Eskom Financial Statements (1985-2017)	LREV
Electricity Price (EP)	Historical average prices (cents per kilowatt)	Cents/kilowatt	Eskom Financial Statements (1985-2017), (NERSA:2017)	LEP
Staff numbers (STAFF)	Number of staff (thousands)	Thousands	Eskom Financial Statements (1985-2017)	LSTAFF
Current Ratio (CR)	Measure of short term liquidity: <i>(Current Assets)/(Current Liabilities)</i>	Ratio from 1.5 – 3	Eskom Financial Statements (1985-2017), Own calculations	LCR
Debt-to-assets Ratio (DAR)	Measure of long-term solvency: <i>(Total Liabilities)/(Total Assets)</i>	Ratio from 0-1	Eskom Financial Statements (1985-2017), Own calculations	LDAO
Gross Value Added (GVA)	Gross value added at constant prices	ZAR million	South African Reserve Bank (SARB) Online Statistical Query	LGVA
Gross Domestic Product (GDP)	Gross domestic product at constant prices	ZAR million	Quantec, Easy Data	LGDP

Source: Authors compilations from Eskom Financial Statements (1985-2017), SARB (2019), Quantec (2019)

Table 4.1 above presents the list of variables to be included in both models, as well as their description, measurements, sources and logarithmic description. The sample size is from 1985 to 2017, which results in 33 observations.

For Model 1, another variable was generated, namely, government debt/GDP which denotes the proportion of government debt relative to GDP. It is also commonly known as the debt-to-GDP ratio.

For model 2, two variables have been generated, namely, Eskom debt/ government debt which represents Eskom’s debt as a proportion of government debt. The second variable is revenue/price, which is the revenue Eskom makes only because of increases in the price of electricity.

This is the linear specification of the models in the study:

$$\ln \frac{GD}{GDP_t} = \beta_0 + \beta_1 \ln ED_t + \beta_2 \ln EP_t + \beta_3 \ln REV_t + \beta_4 \ln STAFF_t + \beta_5 \ln CR_t + \beta_6 \ln DAR_t + \varepsilon_t \dots \dots \dots (4.1)$$

$$\ln \frac{ED}{GDP_t} = \beta_0 + \beta_1 \frac{REV}{EP_t} + \beta_2 STAFF_t + \beta_3 CR_t + \beta_4 DAR_t + \beta_5 GVA_t + \varepsilon_t \dots \dots \dots (4.2)$$

4.3 DESCRIPTIVE STATISTICS, GRAPHICAL ANALYSIS AND CORRELATION MATRIX

In data analysis, descriptive statistics give useful information about a study’s variables.

- The mean is a useful statistic because it tells you the average value of the particular variable over the entire sample period (Studenmund, 2014).
- The median shows the middle value of the variable, while the maximum shows the highest value of the variable.
- The Jarque-Bera (1980) statistic is a test for normality which analyses the statistical distribution of the variable by using kurtosis and skewness as part of its calculation.
- A graphical analysis of variables in the form of a scatter plot or line graph is often a good visual indication of how a series behaves (Asteriou & Hall, 2016).
- Lastly, a correlation matrix is a covariance analysis that indicates whether variables in the study have multi-collinearity (Gujarati, 2004). It is important as it

informs the researcher which variables to include in their study even before estimation

4.3.1 Data generating processes, stationarity and unit root tests

This section discusses the data-generating processes, stationarity and unit root tests.

4.3.1.1 Data-generating processes

Economists are guided by economic theory when modelling data, even though the specifics of that data-generating process may be unknown. However, economic theory does not provide any evidence about the processes of adjustment, exogenous variables, or even whether the variables to be included in the model are relevant (Hendry, Pagan & Sargan, 1984).

Therefore, in trying to characterise the statistical process involved, the study starts with Harrison's (1995) simple stationary univariate model over a time period of $t=1$:

$$y_t = \rho y_{t-1} + u_t \text{ where } |\rho| < 1$$

or

$$(1 - \rho L)y_t = u_t \dots\dots\dots (4.3)$$

Where L is the lag operator, such that $Ly_t = y_{t-1}$

This statistical model states that the variable y_t is generated by its own past along with a residual term, u_t (Harrison, 1995).

An extended version of (4.3), is:

$$y_t = \rho_1 y_{t-1} + \rho_2 y_{t-2} + \dots + \rho_p y_{t-p} + u_t \dots\dots\dots (4.4)$$

This is known as a Markov autoregressive scheme or first order autoregressive scheme AR (1), where the 1 represents one lag.

The following model represents a moving average process, in this case MA (1):

$$y_t = \mu + u_t + u_{t-1} \dots\dots\dots (4.5)$$

Equation 4.5 shows that the current dependent value of y_t is a weighted average of previous and current values of the error term (Ergun & Goksu, 2013).

Equation (4.4) and (4.5) can be combined to become an ARMA model, in which the variable y_t is generated by its own past, a residual term as a weighted average of previous and current values of the error term.

4.3.1.2 Stationarity

In time series, a stationary stochastic process is one in which the series is mean reverting and with no tendency to drift. For stationarity to hold, the stochastic error term ε_t of the particular time series must fulfil the following statistical properties:

- Its expected value of the mean is equal to zero: $E(\varepsilon_t) = 0$
- Constant variance, which means there are no fluctuations around the mean:

$$E(\varepsilon_t^2) = \sigma^2$$
- It is uncorrelated with its past residual terms: $E(\varepsilon_t, \varepsilon_{t-1}) = 0$

Conversely, a non-stationary stochastic process is considered to follow a random walk if the process has a constant mean, changing variance, and changing covariance over time. There are three types of random walk models, namely, 1) pure random walk, 2) random walk with drift, and 3) a random walk with drift and trend (Gujarati, 2004):

$$y_t = y_{t-1} + u_t \dots \dots \dots (4.6)$$

(Pure random walk without drift = non-stationary)

$$y_t = \beta_1 + y_{t-1} + u_t \dots \dots \dots (4.7)$$

(Random walk with drift = non – stationary)

$$y_t = \beta_1 + \delta_t + y_{t-1} + u_t \dots \dots \dots (4.8)$$

(Random walk with drift and deterministic trend = non – stationary)

Non-stationarity is a nuisance in time series modelling because it can create spurious regressions. Spurious regressions, a concept first discovered by Yule (1926), are also called nonsense regressions because they produce false significant statistical relationships. The random walk model is a simple case of a class of integrated processes (Gujarati, 2004).

Differencing non-stationary variables is an effective measure to convert them to stationarity and to change their order of integration, often denoted as $I(d)$, where d is the number of times the series has been differenced. Since non-stationarity is extremely common, most variables are adequate for modelling after they have been differenced once, $I(1)$ or even twice, $I(2)$.

The terms unit roots, non-stationary and random walk are synonymous. Therefore, when a series is non-stationary, one can also say it has a unit root. From equation 4.3, ρ , (ρ) in the AR(1) indicates the presence of a unit root. If the absolute value of ρ is less than 1, the unit root process will forget its past errors and will have a constant mean, constant variance and constant covariance. However, if the absolute value of ρ is greater than or equal to 1, the series does not forget its past error and remains non-stationary, with a non-constant and non-finite mean, variance and covariance.

4.3.1.3 Unit root tests

Since the data-generating processes of the variables in this study are not known beforehand, unit root testing is an accurate method of detecting the presence of unit roots.

There are six-unit root tests which have been established to deal with the problem of non-stationarity. They are the Augmented Dickey-Fuller test (ADF) by Dickey and Fuller (1979), the Phillips-Perron (PP) test of Phillips and Perron (1988), and the detrended Augmented Dickey-Fuller test developed by Elliot, Rothenberg and Stock (1996). This is better known as the Dickey-Fuller Generalised Least Squares (DFGLS) test. There is also the KPSS test by Kwiatkowski, Phillips, Schmidt and Shin (1992), the Elliott, Rothenberg, and Stock Point Optimal test (1996), and the Ng and Perron (2001) test.

This study will only use only two unit root tests, the ADF and PP tests. Dickey and Fuller (1979) developed the ADF test, which was further expanded by Said and Dickey (1984) to detect the presence of non-stationarity. The only limitation of the test is that it can only be used in an Autoregressive Integrated Moving Average (ARIMA) model, provided that the lag length in the AR increases with the sample size. This is why Phillips and Perron (1988) formulated an alternative test for non-stationarity, where the data is not required to fit a certain statistical distribution in order for the test to be carried out. The Dickey-Fuller Generalised Least Squares (DFGLS) test was also

considered as a third alternative to unit root testing but was not applicable for this study because it only gives accurate results for a sample size of 50 and above.

The ADF test estimates the following regression (Gujarati, 2004):

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \alpha_2 \sum_{i=1}^m \alpha_i \Delta y_{t-1} + \varepsilon_t \dots \dots \dots (4.9)$$

Where H_0 : non-stationary, and H_1 : stationary

Dolado, Jenkinson and Sosvilla-Rivero (1990) suggest equation 4.9 as the first model which should be estimated because it is the most generalised. This is because it contains α_0 , which is the intercept term, as well as γ which is the deterministic trend.

The other two models suggest a test without trend, and without trend and intercept.

The choice of the three models is dependent on how a series behaves according to economic theory. The main advantage of the ADF test is its augmentation of the DF test. This augmentation overcomes the problem of higher order serial correlation in the model by including lagged variables on the right-hand side and the error terms converge closer to zero (Asteriou & Hall, 2016). Thereafter, the MacKinnon (1990) critical values embedded in the tests will give an indication of whether there is still the presence of a unit root.

The Phillips-Perron (PP) test estimates the following model (Asteriou & Hall, 2016):

$$\Delta y_{t-1} = \alpha_0 + \gamma y_{t-1} + \varepsilon_t \dots \dots \dots (4.10)$$

Where H_0 : non-stationary, and H_1 : stationary

The PP test is considered a more powerful unit root test if compared to the ADF test because it uses non-parametric statistical methods to correct the t-statistic. Since the PP's t-statistic has the same asymptotic distribution as that of the ADF test, the MacKinnon (1990) critical values still apply to detect the presence of a unit root.

4.4 VECTOR AUTOREGRESSIVE (VAR) MODEL

In keeping with the discussion on data generating processes, AR processes can also be estimated to include a dynamic element to econometric analysis, and this is in the form of a Vector Autoregressive (VAR) model (Lütkepohl, 2006). The VAR has become popular since the 1970s, owing to its ability to incorporate the rich dynamic

structure in time series data with the use of quarterly or monthly data (Lütkepohl, 2006).

This model of a VAR (p) specification is from Lütkepohl (2006):

$$y_t = c + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \dots + \phi_p y_{t-p} + \varepsilon_t \dots\dots\dots (4.11)$$

Where y_{t-1} represents a lag of 1 period up to y_{t-p} , and c is a vector of constants (or intercepts). ϕ_1 represents the unknown parameter of the first lagged period up to ϕ_p , while ε_t is a white noise error term which must fulfil the statistical properties associated with stationarity.

Equation (4.11) can be re-written in matrix form, as a VAR (1) (Gujarati, 2004):

$$\begin{bmatrix} y_{1,t} \\ y_{2,t} \\ \vdots \\ y_{nt} \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \\ \vdots \\ c_{nt} \end{bmatrix} + \begin{bmatrix} \phi_{11} & \phi_{12} \dots\dots & \phi_{1n} \\ \phi_{21} & \phi_{22} \dots\dots & \phi_{2n} \\ \vdots & \vdots & \vdots \\ \phi_{n1} & \phi_{n2} & \phi_{nn} \end{bmatrix} \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \\ \vdots \\ y_{t-n} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \vdots \\ \varepsilon_{nt} \end{bmatrix}$$

$$y_t = c + \phi_j Y_t + \varepsilon_t \dots\dots\dots (4.12)$$

Where:

$y_t = n \times 1$ column vector of observations of the dependent variable Y

c = $n \times 1$ column vector of intercept terms

$\phi_j = n \times n$ column vector of unknown parameters

$\varepsilon_t = n \times 1$ column vector of error terms

4.4.1 VAR lag length criteria

An important aspect when estimating a VAR is its lag length. Ozcicek and McMillin (1999), Braun and Mitnik (1993) and Lütkepohl (1993) all emphasise that estimators of a VAR with different lag lengths give inconsistent impulse response functions and variance decompositions.

The lag length is frequently chosen using Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), and the Hannan-Quinne Criterion (Ozcicek & McMillin, 1999; Lütkepohl & Poskitt, 1991).

According to Gujarati (2004), the use of a high number of lags produces biased t-statistics and reduces the degrees of freedom of a model.

As such, the current study has chosen a lag length of 2 to avoid the aforementioned statistical challenges due to the small sample size of 33 observations.

4.4.2 AR Roots graph/ table

The AR Roots graph is a report of the inverse roots of the characteristic polynomial. From the AR(1) process in equation 4.3:

$$y_t = \rho y_{t-1} + u_t, \text{ for stationarity to hold the absolute value of } \rho \text{ is less than } 1.$$

This implies the inverse characteristic root, $1/\rho$ should be greater than 1. However the AR roots graph shows the inverse roots of the characteristic polynomial which implies that the characteristic roots should lie within a unit circle of values between -1 and 1 (Harris, 1995).

The AR roots graph depicts these roots in the form of scatter plots within a unit circle, while the AR roots table depicts these roots in decimal form. Therefore the AR roots graph and table are tests of a VAR's stability and stationarity.

4.4.3 Impulse response functions (IRFs)

An impulse response function can be represented as:

$$\Delta y_t + \varepsilon_t = \frac{\partial y_{t+s}}{\partial \varepsilon_{1t}} \Delta_1 + \frac{\partial y_{t+s}}{\partial \varepsilon_{2t}} \Delta_2 + \dots + \frac{\partial y_{t+s}}{\partial \varepsilon_{nt}} \Delta_n \dots \dots \dots (4.13)$$

Where, Δ represents the amount by which a component changes and s represents some time period in future. ε_t represents the true shock to a variable within the structural system, thus the impact of a shock to a variable on another variable is $\frac{\partial y_{t+s}}{\partial \varepsilon_{1t}}$.

However, the VAR is a simultaneous equation which means it has the problem of endogeneity (Gujarati, 2004).

In the following primitive system of equations 4.14 and 4.15, y_t and z_t are endogenous.

$$y_t + b_{12}z_t = b_{10} + \delta_{11} y_{t-1} + \delta_{12} z_{t-1} + \varepsilon_{yt} \dots \dots \dots (4.14)$$

$$b_{21}y_t + z_t = b_{20} + \delta_{21} y_{t-1} + \delta_{22} z_{t-1} + \varepsilon_{zt} \dots \dots \dots (4.15)$$

Endogeneity implies that the bivariate system cannot be estimated because the regressors are correlated with the error term. However, restating the VAR in matrix form can resolve this problem, as shown below:

$$\begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix} \begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix} + \begin{bmatrix} \delta_{11} & \delta_{12} \\ \delta_{21} & \delta_{22} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix}$$

Where $\begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix} = B$

$$\begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix} = \gamma_0 = \text{constant}$$

$$\begin{bmatrix} \delta_{11} & \delta_{12} \\ \delta_{21} & \delta_{22} \end{bmatrix} = \gamma_1 = \text{vector of cointegrating parameters.}$$

$$\begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} = \text{lagged variables of } y_t \text{ and } z_t$$

$$\begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix} = \text{vector of stochastic error terms}$$

If $\begin{bmatrix} y_t \\ z_t \end{bmatrix} = X$

$$BX_t = \gamma_0 + \gamma_1 X_{t-1} + \varepsilon_t \dots\dots\dots (4.16)$$

$$X_t = A_0 + A_1 X_{t-1} + e_{t-1} \dots\dots\dots (4.17)$$

Where $A_0 = B^{-1}\gamma_0$; $A_1 = B^{-1}\gamma_1$; $e_t = B^{-1}\varepsilon_t$, thus endogeneity is resolved and the new primitive system becomes equations 4.18 and 4.19:

$$y_t = a_{10} + a_{11} y_{t-1} + a_{12} z_{t-1} + e_{1t} \dots\dots\dots (4.18)$$

$$z_t = a_{20} + a_{21} y_{t-1} + a_{22} z_{t-1} + e_{2t} \dots\dots\dots (4.19)$$

However, this system shows the residual error term e_t , and not ε_t which measures the true shock to the structural system. This implies that the VAR has the problem of identification.

To resolve the problem, an important method of decomposing the residuals in a triangular fashion is used, and this method is called Cholesky ordering (Lütkepohl, 2006).

Recall, $\begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix} = B$, so $B^{-1} = \begin{bmatrix} 1 & -b_{12} \\ 0 & 1 \end{bmatrix}$ when you let $b_{21} = 0$; $e_t = B^{-1}\varepsilon_t$

through the triangulation method, $e_{1t} = \varepsilon_{yt} - b_{12} \varepsilon_{zt}$ and $e_{2t} = \varepsilon_{zt}$

Once identification has been resolved, it is expected that after an initial shock or innovation to a variable, it will gradually converge to a mean of zero, which is the primary assumption of a time series with a normal distribution.

4.4.4 Forecast Variance Decomposition Analysis

Watson (1994) notes that forecast errors are an integral part of econometric analysis. This is because they assist with forecasting. An AR(1) can be used for forecasting where a variable is regressed on its lag. The weakness of this type of forecasting is that it only gives information on one previous time period and on one variable.

In the following forecast errors:

$$y_{T+l} = \mu + \varphi\varepsilon_{T+l} + \varphi_1\varepsilon_{T+l-1} + \varphi_2\varepsilon_{T+l-2} + \dots + \varphi_l\varepsilon_T + \varphi_{l+1}\varepsilon_{T-1} + \varphi_{l+2}\varepsilon_{T-2} \dots \dots \dots (4.20)$$

Where y_{T+l} is $E(y_{T+l}/I_{T^*})$

T = is the current time period

I_{T^*} = information at time T

l = time period in future

φ = represents the amount by which a shock changes

Equation 4.20 shows the expected value or prediction of a variable which is conditional on the last known information about the variable at time T. The drawback of using simple forecast errors is that they are based on previous time periods.

The VAR in equation 4.21, can be expressed as a vector moving average (VMA) in equation 4.22:

$$\begin{bmatrix} y_t \\ x_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \begin{bmatrix} \delta_{11} & \delta_{12} \\ \delta_{21} & \delta_{22} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ x_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{y,t} \\ \varepsilon_{x,t} \end{bmatrix} \dots \dots \dots (4.21)$$

$$\begin{bmatrix} y_t \\ x_t \end{bmatrix} = \begin{bmatrix} \bar{y} \\ \bar{x} \end{bmatrix} + \sum_{i=0}^{\infty} \begin{bmatrix} \phi_{11} & \phi_{12} \\ \phi_{21} & \phi_{22} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ x_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon^s_{y,t-1} \\ \varepsilon^s_{x,t-1} \end{bmatrix} \dots \dots \dots (4.22)$$

In general, the n-step ahead forecast error is:

$$\bar{\varepsilon}_{t+n} = \beta \bar{\varepsilon}_{t+n-1} + \beta^2 \bar{\varepsilon}_{t+n-2} + \dots + \beta^{n-1} \bar{\varepsilon}_{t+1} \dots \dots \dots (4.23)$$

Where

$\bar{\varepsilon}_{t+n}$ = forecast error, and the betas, β are the parameters associated with each forecast error (Sims, 2011).

If the focus is on y_t , the n-step ahead forecast error is:

$$y_{t+1} - E(y_{t+n}) = \phi_{11}(0)\varepsilon^s_{y,t+n} + \phi_{11}(1)\varepsilon^s_{y,t+n-1} + \dots + \phi_{11}(n-1)\varepsilon^s_{y,t+1} + \phi_{12}(0)\varepsilon^s_{x,t+n} + \phi_{12}(1)\varepsilon^s_{x,t+n-1} + \phi_{12}(n-1)\varepsilon^s_{x,t+1} \dots \dots \dots (4.24)$$

Where equation 4.24 shows the forecast error of a variable over 1 horizon. This follows from the assumption that shocks have a unit variance and are uncorrelated (Sims, 2011).

If the variance of the n-step ahead forecast error of y_{t+n} is denoted as $\sigma_y(n)^2$, then

$$\sigma_y(n)^2 = \sigma_y^2[\phi_{11}(0)^2 + \phi_{11}(1)^2 + \phi_{11}(n-1)^2] + \sigma_x^2[\phi_{12}(0)^2 + \phi_{12}(1)^2 + \phi_{12}(n-1)^2] \dots \dots \dots (4.25)$$

Where $\sigma_y(n)^2$ = variance of some time period n

ϕ = respective parameter in the VAR

From equation 4.25 it is possible to decompose the n-step ahead forecast error variance due to each one of these shocks. The proportions of $\sigma_y(n)^2$ due to $\varepsilon^s_{y,t}$ and $\varepsilon^s_{x,t}$ are:

$$\sigma_y^2[\phi_{11}(0)^2 + \phi_{11}(1)^2 + \phi_{11}(n-1)^2]/\sigma_y(n)^2 \dots \dots \dots (4.26)$$

$$\sigma_x^2[\phi_{12}(0)^2 + \phi_{12}(1)^2 + \phi_{12}(n-1)^2]/\sigma_y(n)^2 \dots \dots \dots (4.27)$$

The VAR is a strong analytical tool for forecasting because it forecasts using both the current period and time periods ahead.

The forecast variance decomposition analysis method is also a stronger tool for forecasting because it presents the shocks to the variables in the model in percentage

form. In the simplest explanation, this tool analyses how much of a forecast error in one variable is explained by another.

Both the IRFs and forecast error variance decomposition are influenced by a method called Cholesky Ordering (Harris, 1995; Lütkepohl, 2006; Lütkepohl & Poskitt, 1991), and is usually analysed over a horizon of 20 periods. Since the study's sample size is short, 10 periods were chosen.

This section has shown that the VAR is a strong model of estimation because it is able to overcome the problem of endogeneity. Another important aspect of the VAR is that it is able to overcome the identification problem found in simultaneous equations, and finally, it is relatively easy to estimate.

4.5 COINTEGRATION

Cointegration is a concept developed by various econometric theorists, including Granger (1981), Engle and Granger (1987) and Johansen (1995). Two or more series are cointegrated if they form a long run equilibrium relationship, even though they may be non-stationary (Harris, 1995).

4.5.1 Cointegration tests

There are two types of cointegration tests, namely, the Engle-Granger two-step model and the Johansen-Julius cointegration test.

The **Engle-Granger two-step model** is a test for cointegration which is able to incorporate both the short run and long run dynamics of a cointegrated equation into its model. Engle and Granger (1987) also used this two-step procedure to construct an error correction model (ECM), which enables them to separate these short and long run components.

The **Johansen procedure** is applied to estimate a Vector Error Correction Model (VECM). A VECM is used to detect more than one cointegrating equation. However, as with the VAR, a VECM is highly parameterised and is more applicable to a large sample size. Hence, the study has chosen the Engle-Granger two-step model due to the small sample size of 33 observations.

4.5.1.1 Engle-Granger two-step model

The following steps are used when testing for cointegration using the Engle-Granger two-step model (Harris, 1995; Gujarati, 2004):

- i) An estimation of the long run equation, where signs and magnitudes are noted;
- ii) The long run equation is evaluated according to the *a priori* signs and magnitudes expected, according to economic theory;
- iii) The long run equation is evaluated statistically, where a residual series is generated and p-values will be used to reject or fail to reject the null hypothesis of no cointegration;
- iv) An ECM is constructed by including the cointegrating component, which is the lagged residual, which has to be negative and statistically significant;
- v) The ECM is evaluated where the residual coefficient must be negative and significant; the t-values must be significant, and the R-squared must be acceptable; and
- vi) The ECM should also be evaluated using post estimation diagnostic tests

While these steps are the conventional method of constructing an ECM, a more robust test for cointegration can be applied after step three. This is the MacKinnon response surface testing which provides critical values for cointegrating tests (MacKinnon, 1990). These critical values are powerful as they incorporate the dependencies of statistics' quantiles on the number of variables in the ECM, the choice of the deterministic components and the sample size (Ericsson & MacKinnon, 2002).

This is an important innovation in testing for cointegration because the residual series produced from the long run cointegrating equation in the E-Views software do not take the aforementioned concepts into consideration.

4.5.2 Engle-Granger error correction model

According to Asteriou and Hall (2016), in the event that Y_t and X_t are both non-stationary $I(1)$, the following regression will not give us adequate estimates of $\hat{\beta}_1$ and $\hat{\beta}_2$:

$$Y_t = \beta_1 + \beta_2 X_t + u_t \dots\dots\dots (4.28)$$

Once the two variables are differenced, they become $\Delta Y_t \sim I(0)$ and $\Delta X_t \sim I(0)$ in the following regression model:

$$\Delta Y_t = \alpha_1 + \alpha_2 \Delta X_t + \Delta u_t \dots\dots\dots (4.29)$$

However, even though the problem of spurious regressions is resolved, equation 4.29 only gives information about the short run relationship between Y_t and X_t .

In economics, the main interest is the long run relationship between variables, and this is where the concept of cointegration and the ECM come into play.

From equation 4.29, there is no longer spurious regression, and the new equation constructed from equation 4.28 becomes:

$$\hat{u}_t = Y_t - \hat{\beta}_1 - \hat{\beta}_2 X_t \dots\dots\dots (4.30)$$

From equations 4.28, 4.29 and 4.30, the following ECM can be constructed:

$$\Delta Y_t = \alpha_0 + b_1 \Delta X_t - \pi \hat{u}_{t-1} + Y_t \dots\dots\dots (4.31)$$

Where b_1 = short run impact that measures the impact that X_t will have on ΔY_t

π = speed of adjustment which shows to what extent the disequilibrium from the previous period is corrected in the current period, Y_t

$\hat{u}_{t-1} = Y_{t-1} - \hat{\beta}_1 - \hat{\beta}_2 X_{t-1}$ where $\hat{\beta}_2$ measures the long run response of the model.

The following model is the ECM of the study:

$$\Delta \ln \frac{ED}{GD} = \beta_0 + \sum_{i=1}^m \beta_1 \Delta \ln \frac{ED}{GD}_{t-1} + \sum_{i=1}^m \beta_2 \Delta \ln \frac{REV}{EP}_{t-1} + \sum_{i=0}^m \beta_3 \Delta \ln STAFF_{t-1} + \sum_{i=0}^m \beta_4 \Delta \ln CR_{t-1} + \sum_{i=0}^m \beta_5 \ln DAR_{t-1} + \sum_{i=0}^m \beta_6 \ln GVA_{t-1} + \delta ECM_{t-1} + u_t \dots (4.32)$$

Where:

$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$ = short run impact of the respective independent variables on $\Delta \frac{ED}{GD}$

δ = speed of adjustment which shows to what extent the disequilibrium from the previous period is corrected in Y_t

u_t = contains the long run components of the model.

According to Asteriou and Hall (2016), as well as Harris (1995), the main advantages of the ECM are:

- i) The model is relatively simple to construct;
- ii) Once stationarity has been achieved, the properties of Ordinary Least Squares (OLS) can be used to obtain consistent estimates of the cointegrating vector;
- iii) The model combines the short run components as well as the long run equilibrium; and
- iv) The ECM produces a coefficient which is the speed of adjustment to equilibrium.

4.6 POST-ESTIMATION DIAGNOSTIC TESTS

It is important to perform diagnostic tests, even after the ECM has been estimated, in order to investigate if it has tendencies which violate the classical OLS assumptions. The specific assumptions are that OLS estimates have a normal distribution, no serial or auto correlation, and no heteroskedasticity. Another critical assumption is that the model is correctly specified.

The section below discusses some of the post-estimation diagnostic tests for the current study's ECM.

4.6.1 Jarque-Bera Test

According to the central limit theorem, when a sample is large enough, the joint sampling distribution should follow a normal distribution. Jarque and Bera (1980)

formulated an equation which tests residuals for normality, where the null and alternative hypotheses are as follows:

H_0 : Residuals are normally distributed.

H_1 : Residuals are not normally distributed.

Its test statistic is calculated using the formula in equation 4.33:

$$JB = \frac{N-k}{6} \left[S^2 + \frac{(K-3)^2}{4} \right] \dots \dots \dots (4.33)$$

Where $JB \sim \chi^2$

N= number of observations

k = number of estimated parameters

S = skewness of variable

K = kurtosis of variable

4.6.2 Ramsey RESET

The Ramsey (1969) RESET test seeks to investigate the probability of misspecification in the regression model. It does so by calculating an F-statistic which has been obtained from a regression on the estimated values of the model.

The F-statistic is calculated as follows:

$$F = \frac{(R^2_{new} - R^2_{old}) / \text{number of new regressors}}{(1 - R^2_{new}) / \text{number of parameters in new model}} \dots \dots \dots (4.34)$$

As a result, the Ramsey RESET test investigates the relationship between the estimated residuals and estimated regression model.

4.6.3 Ljung-Box Q Test

According to OLS assumptions, the residual error terms of different observations should not be correlated (Gujarati, 2004). The Ljung-Box Q statistic tests for autocorrelation in the residuals to detect the presence or absence of white noise. The null and alternative hypotheses are as follows:

H_0 : Residuals contain no autocorrelation up to any order k, residuals are white noise.

H_1 : Residuals contain autocorrelation up to any order k, residuals are not white noise.

Its test statistic is calculated using the formula in equation 4.35:

$$Q_{LB} = T(T + 2) \sum_{j=1}^k \frac{r_j^2}{T-j} \dots\dots\dots (4.35)$$

Where $Q_{LB} \sim \chi^2$

T = number of observations

K = the highest order of autocorrelation for which to test

r_j^2 = the j-th autocorrelation

4.6.4 Breusch–Godfrey Test

The Breusch–Godfrey Test is also a test for serial correlation. This test is similar to the Ljung Box Q statistic, however, it does so through an augmented residual regression (Gujarati, 2004). It can also be applied whether lagged dependent variables are included or not.

The null and alternative hypotheses are as follows:

H_0 : No autocorrelation up to the p-th order.

H_1 : Autocorrelation exists up to the p-th order.

Where $LM_{BG} \sim \chi^2$

From $y_t = \beta X_t + \varepsilon_t$, the augmented regression for testing autocorrelation up to the p-th order is:

$$\hat{\varepsilon}_t = \hat{\beta} X_t + \alpha_1 \hat{\varepsilon}_{t-1} + \alpha_2 \hat{\varepsilon}_{t-2} + \dots\dots\dots + \alpha_p \hat{\varepsilon}_{t-p} + \omega_t \dots\dots\dots (4.36)$$

Where

$\hat{\varepsilon}$ = the estimated residuals used to estimate the augmented regression.

$\hat{\beta}$ = parameter of independent variable

α = parameters of lagged estimated residuals

ω_t = residual error term

4.6.5 Engle's Autoregressive Residuals Conditional Heteroskedasticity Lagrange Multiplier (ARCH LM) Test

Heteroskedasticity among residual error terms is a violation of the classical OLS assumptions. It is an instance where the error term's variance is not constant (Gujarati, 2004). The skewness of the statistical distribution of the series can result in a non-constant variance of the error term. Incorrect data transformation, such as incorrect differencing, could also give rise to heteroskedasticity. This test investigates the presence of inconsistent variance among the residuals.

The null and alternative hypotheses are as follows:

H_0 : No autoregressive conditional heteroskedasticity up to order q .

H_1 : Autoregressive conditional heteroskedasticity exists up to order q .

Where $LM_E \sim \chi^2$

From $y_t = \beta X_t + \varepsilon_t$, the augmented regression for testing heteroskedasticity up to the q -th order is:

$$\hat{\varepsilon}_t = \alpha_1 \hat{\varepsilon}_{t-1} + \alpha_2 \hat{\varepsilon}_{t-2} + \dots + \alpha_p \hat{\varepsilon}_{t-p} + \omega_t \dots \dots \dots (4.37)$$

Where:

$\hat{\varepsilon}$ = the estimated residuals used to estimate the augmented regression.

α = parameters of lagged estimated residuals

ω_t = residual error term

4.6.6 White's Heteroskedasticity Test

White's Heteroskedasticity Test is another test for heteroskedasticity. According to White (1980), heteroskedasticity results in faulty inferences when testing statistical hypotheses. It is desirable that a model should be homoskedastic in order to guarantee the reliability of its estimates. The White's test uses the following null and alternative hypotheses:

H_0 : No heteroskedasticity.

H_1 : Presence of heteroskedasticity exists.

From $y_t = \beta_0 + \beta_1 X_t + \beta_2 Z_t + \varepsilon_t$, the augmented regression is calculated as follows:

$$\widehat{\varepsilon}_t^2 = \alpha_0 + \alpha_1 x_t + \alpha_2 z_t + \alpha_3 x_t^2 + \alpha_4 z_t^2 + \alpha_5 x_t z_t + \omega_t \dots \dots \dots (4.38)$$

Where:

$\hat{\varepsilon}$ = the estimated residuals used to estimate the augmented regression.

$\alpha_{1,2,3,4,5}$ = parameters of independent variables x_t and z_t ; squared parameters of independent variables and the parameter for cross terms, $x_t z_t$

ω_t = residual error term

4.7 CONCLUSION

This chapter outlined the estimation techniques which will be used to generate the empirical results of this study. The chapter started by detailing the data sources, together with the description of the variables and model specifications. The unit root tests which would be used for the study, namely, the ADF test and Phillips-Perron test were also discussed.

The estimation techniques of the VAR were also discussed, including the VAR lag length criteria, the AR roots table and graph, as well as other estimation techniques, such as impulse response functions and forecast variance decomposition analyses. The chapter also concluded that the VAR is a strong analytical model since it overcomes the problem of endogeneity and identification.

The chapter also discussed the two-step Engle-Granger cointegration test, which is used to estimate the ECM. The discussion highlighted the fact that a small sample size can require a basic two-step Engle-Granger cointegration test, rather than the Johansen-Julius cointegration test. This is because the latter test is highly parametrised, and can result in a significant reduction in the degrees of freedom in a small sample, which can lead to biased statistics.

The chapter also showed that once the ECM is constructed, post-diagnostic tests still have to be run. These tests are the Jarque-Bera test, Ramsey RESET Test, Ljung Box Q statistic, Breusch Godfrey test, ARCH LM test and White's test.

Overall, the tests are conducted to make sure the ECM conforms to the assumptions of OLS, which include the normal distribution of residuals, correct specification, homoskedasticity and no autocorrelation.

CHAPTER 5: EMPIRICAL ANALYSIS

5.1 INTRODUCTION

The purpose of this chapter is to provide the study's empirical analysis. Section 5.2 starts with a brief outline of the descriptive statistics and graphical analysis of all the variables. Section 5.3 tabulates and deliberates the results of the unit root testing performed on all the variables. Section 5.4 discusses the empirical results from the estimated VAR model, while Section 5.5 outlines the empirical results for the ECM. Section 5.6 conducts the Engle-Granger Cointegration Test, and Section 5.7 constructs the ECM. Section 5.8 contains the post-diagnostic tests, and Section 5.9 concludes the study.

Table 5.1 (on the next page) presents the descriptive statistics of the study, while Figure 5.1 below it presents a graphical analysis of the variables relevant to the study which will be discussed in Section 5.2.

Table 5.1: Descriptive statistics

	GD	ED	REV	EP	STAFF	GDP	CR	DAR	GVA
Mean	48846.00	116187.3	48272.48	23.41758	42496.06	1585178.	0.970566	0.816387	1404899.
Median	29492.00	44438.00	25029.00	13.76000	39952.00	1046144.	0.949930	0.820444	936503.0
Maximum	206778.0	534067.0	177136.0	81.77000	78119.00	4653579.	1.453054	0.951866	4090906.
Minimum	1185.000	20747.00	4625.000	4.120000	24289.00	131676.0	0.443368	0.609292	120568.0
Std. Dev.	56237.39	142081.0	50633.60	22.22232	11644.67	1388955.	0.241013	0.105448	1220460.
Skewness	1.316221	1.771141	1.366692	1.448267	1.054178	0.804363	0.369684	-0.331439	0.790418
Kurtosis	4.050690	4.990159	3.480018	3.717544	4.186013	2.352983	2.889707	2.051333	2.318364
Jarque-Bera	11.04634	22.69917	10.58999	12.24407	8.046214	4.134121	0.768392	1.841643	4.075044
Probability	0.003993	0.000012	0.005017	0.002194	0.017897	0.126557	0.680998	0.398192	0.130351
Sum	1611918.	3834182.	1592992.	772.7800	1402370.	52310862	32.02866	26.94079	46361653
Sum Sq. Dev.	1.01E+11	6.46E+11	8.20E+10	15802.60	4.34E+09	6.17E+13	1.858794	0.355815	4.77E+13
Observations	33	33	33	33	33	33	33	33	33

Source: Author's Computation from E-Views 9

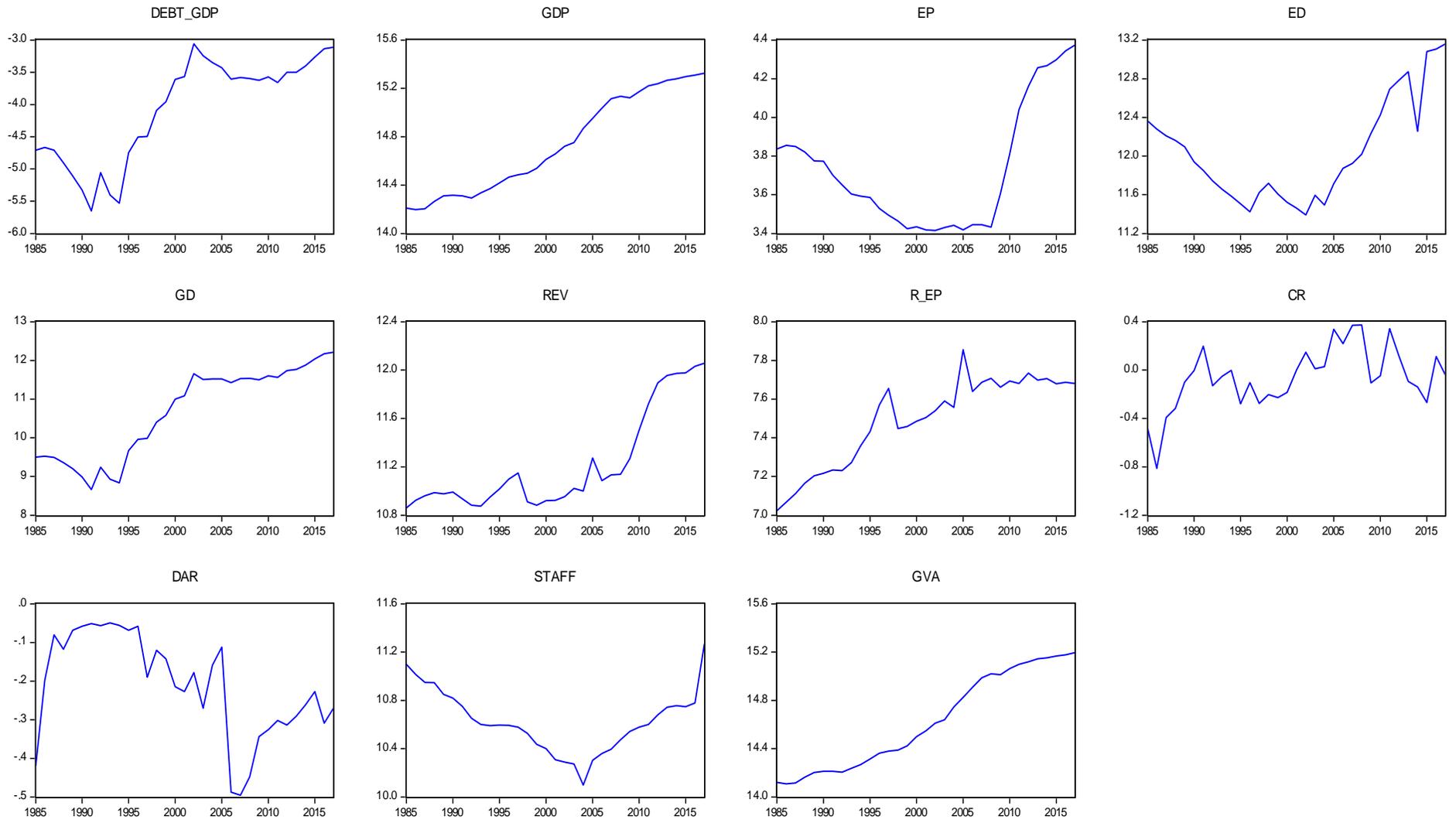


Figure 5.1: Graphical analysis of variables

Source: Author's computation from E-Views 9

5.2 DESCRIPTIVE STATISTICS AND GRAPHICAL ANALYSIS

This section presents the descriptive statistics and graphical analysis of the study.

5.2.1 Descriptive statistics

The descriptive statistics in Table 5.1 offer interesting information about the study's variables from 1985 to 2017. On average, government debt was R4 8846 million, while Eskom debt throughout the same period was R116, 187 million. The average electricity price has been 23,42 c/kW, where the cheapest electricity price throughout the sample period was 4,12 c/kW and the highest was 81,77 c/kW. The average revenue at Eskom is certainly high at R48, 272 million, with staff numbers being fairly consistent throughout the years at an average of 42, 496.

Gross Domestic Product (GDP) on average was R1, 404, 899 million, with its highest value being R4, 090, 906 million. According to ratio analysis, a company with a current ratio greater than 1.5 is in a good position to settle its short-term debt obligations over the next 12 months should it be liquidated (Odaló, 2016). On average, Eskom's current ratio has been close to 1.5, however, Eskom's lowest current ratio throughout the sample period was 0.44. This is an indication that Eskom is illiquid.

The debt-to-assets ratio measures what proportion of the company's assets is financed by debt (Yazdanfar & Öhman, 2014). A good debt-to-assets ratio is considered less than 0.4, which indicates low risk. However, Eskom's debt-to-assets ratio has been well above 0.4 throughout the sample period, with an average ratio of 0.82 and a maximum of 0.95. Lastly, as a result of increases in the electricity price, the revenue is on average at R1,837,12 million.

The Jarque-Bera (1980) statistic indicates that GDP, current ratio, debt-to-assets ratio and gross value added (GVA) all have a normal distribution.

5.2.2 Graphical analysis

An informal method of detecting non stationarity is through graphical analysis. Figure 5.1 shows that all the variables in the study are non-stationary at levels. The debt-to-GDP ratio and government debt have a similar trend, while the debt-to-GDP ratio increases more than government debt from 1990. This after the lifting of the economic sanctions against South Africa and the release of Nelson Mandela from political

imprisonment (Calitz *et al.*, 2011). As expected, the growth of GDP and GVA from 1985 – 2017 show an increase that is associated with a time trend. The electricity price shows a steady decline from 1985 – 2000. This is as a result of the De Villiers Commission which instructed Eskom not to charge cost-reflective prices (Kantor, 1988).

While the electricity price increased slightly after the building programme in 2001, there was a sharp increase in the electricity price from 2008 onwards, which could have been attributed to the aversion of load shedding (Eskom, 2018). Eskom's debt has also increased significantly from 2008. This is due to the increased access to funds through internal financing (Modigliani & Miller, 1958; Yazdanfar & Öhman, 2014).

Revenue at Eskom has steadily increased during the sample period, however, it has done so as a result of electricity price increases. This shows that the utility relies heavily on price increases, rather than sales. This is typical of a monopoly because they typically abuse their dominance in the market (Varian, 2010).

The current ratio and debt-to-assets ratio are an indication of the company's liquidity and solvency (Gurbuz *et al.*, 2016; Odalo, 2016). Both ratios indicated that Eskom's financial performance has been poor over the years (Klimczak, 2004). Staff numbers are an indicator of the productivity of a firm (Snowdon & Vane, 2005). Eskom's staff numbers were steadily declining from 1985, and only started to increase from 2004.

5.3 UNIT ROOT TEST RESULTS

The Augmented Dickey-Fuller test (ADF) was pioneered by Dickey and Fuller (1979). Phillips and Perron (1988) also went on to establish their own unit root test, the PP. The null hypothesis is non-stationary. If a test statistic is statistically significant, the null hypothesis is rejected, which suggests a stationary series. The Dickey-Fuller Generalized Least Squares (DFGLS) test was also considered as another comparative method for unit root testing. However, the test does not produce the most accurate results for a sample of less than 50 observations. Since the sample size of the study is 33 observations, it was best to exclude the DFGLS unit root test results.

Table 5.2 (on the next page) presents the results of the unit root tests at levels. This is followed by Table 5.3 that presents the results of the unit root tests at first difference.

Table 5.2: Unit root tests at levels

Variable	Model	ADF					PP				
		Lags	$\alpha = 1\%$	$\alpha = 5\%$	$\alpha = 10\%$	t-stat	Band-width	$\alpha = 1\%$	$\alpha = 5\%$	$\alpha = 10\%$	t-stat
GD/GDP	Trend & Intercept	7	-4.285	-3.563	-3.215	-2.669	4	-4.273	-3.556	-3.212	-1.563
	Intercept	7	-3.662	-2.960	-2.619	-2.576	4	-3.653	-2.957	-2.617	-1.423
GD	Trend & Intercept	1	-4.285	-3.563	-3.215	-2.943	4	-4.273	-3.557	-3.212	-1.938
	Intercept	1	-3.661	-2.960	-2.619	-1.180	4	-3.653	-2.957	-2.617	-1.433
GDP	Trend & Intercept	0	-4.273	-3.558	-3.212	-1.493	1	-4.273	-3.556	-3.212	-1.468
	Intercept	0	-3.654	-2.957	-2.617	-7.608	0	-3.654	-2.957	-2.617	-7.608
GVA	Trend & Intercept	0	-4.273	-3.558	-3.212	1.502	1	-4.273	-3.558	-3.212	1.333
	Intercept	0	-3.654	-2.957	-2.617	12.786	3	-3.654	-2.957	-2.617	9.453
ED/GD	Trend & Intercept	0	-4.273	-3.558	-3.212	-1.600	3	-4.273	-3.556	-3.212	-1.433
	Intercept	0	-3.653	-2.957	-2.617	-2.281	1	-3.654	-2.957	-2.617	-2.295
ED	Trend & Intercept	0	-4.273	-3.556	-3.212	-1.537	2	-4.273	-3.556	-3.212	-1.203
	Intercept	1	-3.662	-2.960	-2.61916	1.588	9	-3.654	-2.957	-2.617	2.001
EP	Trend & Intercept	1	-4.285	-3.563	-3.216	-2.094	4	-4.273	-3.558	-3.212	-1.172
	Intercept	1	-3.661	-2.960	-2.619	0.4681	3	-3.654	-2.957	-2.617	0.3201
R/EP	Trend & Intercept	0	-4.273	-3.558	-3.212	-2.606	2	-4.273	-3.558	-3.212	-2.480
	Intercept	0	-3.654	-2.957	-2.617	-1.999	3	-3.654	-2.957	-2.617	-2.084

Variable	Model	ADF					PP				
		Lags	$\alpha = 1\%$	$\alpha = 5\%$	$\alpha = 10\%$	t-stat	Bandwidth	$\alpha = 1\%$	$\alpha = 5\%$	$\alpha = 10\%$	t-stat
REV	Trend & Intercept	0	-4.273	-3.557	-3.212	-1.700	3	-4.273	-3.558	-3.212	-2.018
	Intercept	0	-3.654	-2.957	-2.617	-0.471	2	-3.654	-2.957	-2.617	-0.488
STAFF	Trend & Intercept	0	-4.273	-3.558	-3.212	0.764	4	-4.273	-3.558	-3.212	1.469
	Intercept	0	-3.653	-2.957	-2.617	-0.681	3	-3.654	-2.957	-2.617	-1.024
CR	Trend & Intercept	0	-4.273	-3.558	-3.212	-3.090	1	-4.273	-3.558	-3.212	-3.004
	Intercept	0	-3.654	-2.957	-2.617	-2.964	0	-3.654	-2.957	-2.617	-2.964
DAR	Trend & Intercept	0	-4.273	-3.558	-3.212	-4.154	1	-4.273	-3.558	-3.212	-4.144
	Intercept	0	-3.653	-2.957	-2.617	-2.429	3	-3.654	-2.957	-2.617	-2.563

Source: Author's computation from E-Views 9, where:

* Statistically significant at a 10% level

** Statistically significant at a 5% level

*** Statistically significant at a 1% level

Table 5.3: Unit root tests at first difference

Variable	Model	ADF					PP				
		Lags	$\alpha = 1\%$	$\alpha = 5\%$	$\alpha = 10\%$	t-statistic	Bandwidth	$\alpha = 1\%$	$\alpha = 5\%$	$\alpha = 10\%$	t-statistic
GD/GDP	Trend & Intercept	1	-4.285	-3.563	-3.215	-5.546***	4	-4.285	-3.563	-3.215	-5.616***
	Intercept	1	-3.662	-2.960	-2.619	-5.609***	3	-3.661	-2.960	-2.619	-5.665***
GD	Trend & Intercept	1	-4.285	-3.568	-3.218	-5.567***	3	-4.285	-3.563	-3.215	-5.647***
	Intercept	1	-3.662	-2.961	-2.619	-5.628***	4	-3.661	-2.960	-2.619	-5.691***
GDP	Trend & Intercept	0	-4.284	-3.562	-3.215	-3.328*	2	-4.284	-3.563	-3.215	-3.337*
	Intercept	0	-3.661	-2.960	-2.619	-3.465**	2	-3.661	-2.960	-2.619	-3.478**
GVA	Trend & Intercept	0	-4.284	-3.562	-3.215	-3.213*	0	-4.28	-3.562	-3.215	-3.213*
	Intercept	0	-3.661	-2.960	-2.619	-3.354**	3	-3.661	-2.960	-2.619	-3.354**
ED/GD	Trend & Intercept	0	-4.284	-3.562	-3.215	-7.612***	1	-4.284	-3.562	-3.215	-7.651***
	Intercept	0	-3.661	-2.960	-2.619	-6.621***	3	-3.661	-2.960	-2.619	-6.537***
ED	Trend & Intercept	0	-4.284	-3.562	-3.215	-8.206***	8	-4.284	-3.562	-3.215	-10.920***
	Intercept	0	-3.661	-2.960	-2.619	-7.528***	0	-3.661	-2.960	-2.619	-7.528***
EP	Trend & Intercept	0	-4.284	-3.562	-3.215	-2.551	1	-4.284	-3.562	-3.215	-2.586
	Intercept	0	-3.661	-2.960	-2.619	-2.378	2	-3.661	-2.960	-2.619	-2.509
	None	0	-2.642	-1.952	-1.610	-1.942**	0	-2.642	-1.952	-1.610	-1.942**
R/EP	Trend & Intercept	0	-4.284	-3.562	-3.215	-8.083***	7	-4.284	-3.562	-3.215	-14.819***

Variable	Model	ADF					PP				
		Lags	$\alpha = 1\%$	$\alpha = 5\%$	$\alpha = 10\%$	t-statistic	Bandwidth	$\alpha = 1\%$	$\alpha = 5\%$	$\alpha = 10\%$	t-statistic
	Intercept	0	-3.661	-2.960	-2.619	-7.819***	2	-3.661	-2.960	-2.619	-7.919***
REV	Trend & Intercept	0	-4.284	-3.562	-3.215	-5.042***	1	-4.284	-3.562	-3.215	-5.034***
	Intercept	0	-3.661	-2.960	-2.619	-5.130***	1	-3.661	-2.960	-2.619	-5.124***
STAFF	Trend & Intercept	0	-4.284	-3.562	-3.215	-4.003***	2	-4.284	-3.563	-3.215	-3.792**
	Intercept	0	-3.661	-2.960	-2.619	-2.320	2	-3.661	-2.960	-2.619	-2.218
CR	Trend & Intercept	1	-4.296	-3.568	-3.218	-5.335***	2	-4.285	-3.562	-3.215	-7.982***
	Intercept	1	-3.670	-2.964	-2.621	-5.181***	0	-3.662	-2.960	-2.619	-7.531***
DAR	Trend & Intercept	0	-4.285	-3.562	-3.215	-5.991***	6	-4.285	-3.563	-3.215	-6.652***
	Intercept	0	-3.662	-2.960	-2.619	-6.15***	6	-3.661	-2.960	-2.619	-6.962***

Source: Author's computation from E-Views 9, where:

* Statistically significant at a 10% level

** Statistically significant at a 5% level

*** Statistically significant at a 1% level

In Table 5.2, the unit root tests show that all variables are non-stationary at levels. In Table 5.3, the unit root tests show that all variables are stationary at first difference. The study decided to test stationarity using two models under the ADF and PP tests. These are the trend, as well as trend and intercept. This is because most variables have a trend, or a trend and intercept.

5.4 VECTOR AUTOREGRESSION (VAR) MODEL RESULTS

The following sub-section will present the results for the study's VAR model. The section displays results for the VAR's correlation matrix, AR roots graph and table. The section also discusses the impulse response functions and forecast error decomposition analysis. The model below is the study's VAR:

$$GD/GDP = f(EP, ED, REV, STAFF, CR, DAR) \dots \dots \dots (5.1)$$

According to Mohr (2016), GDP is the total value of all final goods and services produced in a country. It is also an important measure of the performance of an economy from the demand or consumer side.

The study has emphasised that SOEs are a contingent liability to the state because they increase government debt, usually in the form of state-guaranteed loans, and this has been the point of emphasis with Eskom. To capture the effect of Eskom's debt on the economy as a whole, this model has included GDP as a variable, where it has been generated as government debt relative to GDP. This was done with the intention to highlight that government debt does have an effect on GDP, and it is often negative. Furthermore, this variable has been included in the model to show that Eskom's debt as a proportion of government debt also has a negative effect on GDP.

Table 5.4 below presents the VAR correlation matrix. This is a covariance analysis which indicates the presence of multicollinearity amongst the variables. When a variable is highly correlated with one or more variables in a model, it suggests that it can be linearly predicted with a high degree of accuracy. However, the estimates of the model will be biased owing to the fact that one will not be able to completely isolate one estimate from another. Thus, a correlation matrix is important because it indicates which variables are suitable to be included in the model

Table 5.4: VAR correlation matrix

Correlation Probability	GD/GDP	EP	REV	ED	STAFF	CR	DAR
GD/GDP	1.000						
EP	0.470 (0.006)*	1.000 -----					
REV	0.458 (0.0074)*	0.992 (0.000)*	1.000 -----				
ED	0.344 (0.050)*	0.972 (0.000)*	0.956 (0.000)*	1.000			
STAFF	-0.003 (0.987)*	-0.032 (0.861)*	-0.129 (0.475)*	0.0854 (0.637)*	1.000		
CR	-0.110 (0.544)*	0.398 (0.022)*	0.457 (0.008)*	0.358 (0.041)*	-0.512 (0.002)*	1.000	
DAR	0.246 (0.167)*	-0.442 (0.010)*	-0.466 (0.006)*	-0.537 (0.001)*	0.087 (0.630)*	-0.297 (0.094)*	1.000

Source: Author's computation from E-Views 9, where:

() indicates the p-values, and

* Statistically significant at a 10% level

** Statistically significant at a 5% level

*** Statistically significant at a 1% level

Table 5.4 shows the correlation matrix of the VAR model. The p-values show the level of significance of the correlation between all the independent variables and their dependent variable (Steiger, 1980).

The null hypothesis is that there is no correlation, but when the p-value is statistically significant at either a 10%, 5% or 1% level of significance, one can reject the null hypothesis in favour of the presence of correlation.

According to the correlation matrix, all the variables have a significant correlation with the dependent variable, apart from staff, the current ratio, and the debt-to-assets ratio.

Henceforth, staff, the current ratio, and the debt-to-assets ratio are excluded from the model.

5.4.1 VAR lag order selection criteria

The Lag selection criteria indicate that two lags should be used to estimate the model. This is due to the fact that the sample size is small, at 33 observations, thus a large number of lags would decrease the degrees of freedom, thereby creating bias results.

The most referenced criterion is the Akaike Information criterion (AIC) and the Schwartz information Criterion (SC) (MacKinnon, Haug & Michelis, 1999; Ozcicek & McMillin, 1999; Lütkepohl & Poskitt, 1991).

5.4.2 Autoregressive (AR) roots graph & AR roots table

Figure 5.2 below shows the inverse roots of autoregressive characteristic polynomial of the VAR, while Table 5.5 presents the roots of its characteristic polynomial.

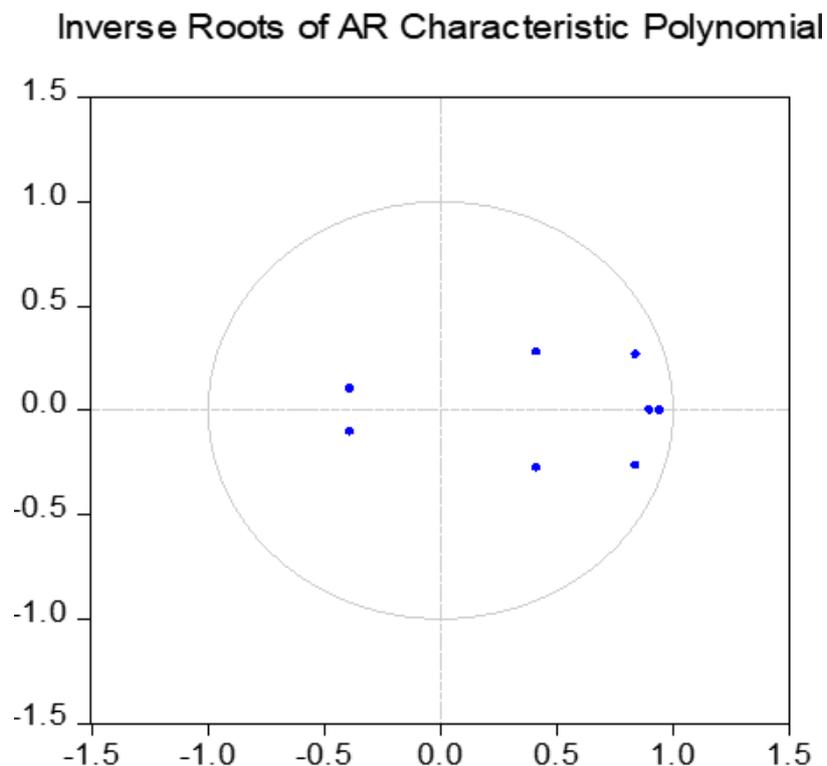


Figure 5.2: Inverse roots of autoregressive characteristic polynomial

Source: Author's computation from E-Views 9

Table 5.5: Roots of characteristic polynomial

Root	Modulus
0.945303	0.945303
0.900831	0.900831
0.841628 - 0.265675i	0.882565
0.841628 + 0.265675i	0.882565
0.414429 - 0.277926i	0.498993
0.414429 + 0.277926i	0.498993
-0.387862 - 0.103379i	0.401403
-0.387862 + 0.103379i	0.401403

Source: Author's computation from E-Views 9

The AR roots graph shows the inverse roots of the characteristic polynomial, which implies that the characteristic roots should lie within a unit circle of values between -1 and 1 (Harris, 1995).

In Figure 5.2, all the roots are inside the unit circle, with none being on or outside the circle.

The AR roots table (Table 5.5) indicates that the VAR is stable, since all modulus are less than 1. The highest root is 0.945303.

5.4.3 Impulse response functions

An impulse response function shows the proportion of the movements in a sequence or variable due to its 'own' shocks, versus shocks to other variables (Gujarati, 2004; Lütkepohl, 2006).

In Figure 5.3 (on the next page), impulse response functions are displayed for the VAR up to the 10th time period. The diagonal panels from the top left to the bottom right indicate the impulse response functions of the variables to themselves. All stationary time series are expected to mean revert, and therefore are expected to decay to zero in the long run (Gujarati, 2004; Lütkepohl, 2006).

This is also expected with impulse response functions.

Response to Cholesky One S.D. Innovations ± 2 S.E.

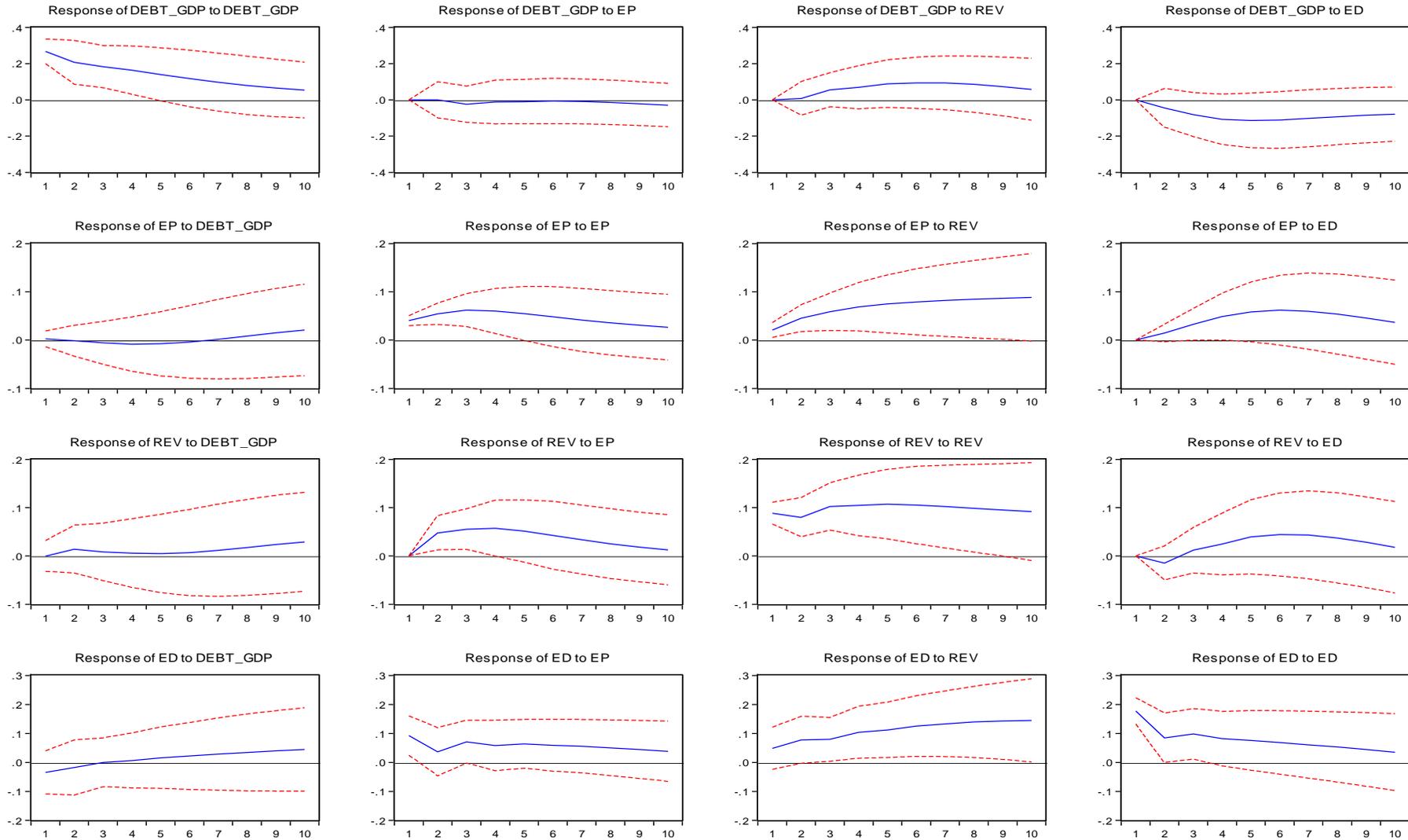


Figure 5.3: Impulse response functions

Source: Author's computation from E-Views 9

As seen in Figure 5.3 above, this is the case with GD/GDP and ED, where all stationary time series are expected to revert to the mean, and therefore are expected to decay to zero in the long run. However, the electricity price is far from the mean and does not appear to be mean reverting in the long run. This implies that the electricity price will continue to rise because Eskom will keep making applications with NERSA for more tariff increases.

Eskom's revenue is also reverting away from the mean of zero and is in fact increasing. This implies that in the long run, much of its revenues will continue to increase, most likely owing to increases in the electricity price, and not necessarily increases in sales.

In order to interpret the other impulse response functions from Figure 5.3, the discussion below will explain the response of each variable when one variable is shocked. The responses will be explained according to the following Cholesky Ordering: GD/GDP, EP, REV, ED. This ordering assesses the variables according to their contemporaneous effects.

GD/GDP: A one standard deviation shock to the debt-to-GDP ratio causes it to decrease from the 1st period. It further decreases after the 2nd period. Since the study chose a horizon of 10 periods due to a small sample size, it can be assumed that the variables decay after the 10th time period. The contemporaneous effect of the debt-to-GDP ratio on itself shows that a large proportion of its innovation is explained by its own shock. This confirms the Ricardian Equivalence Hypothesis by Barro (1979).

The one standard deviation shock to the debt-to-GDP ratio has no noticeable contemporaneous impact on the electricity price. It is only between the 2nd and 6,5th period that a minor decrease in the electricity price is seen.

The one standard deviation shock to the debt-to-GDP ratio also has a minor contemporaneous effect on revenue. There is an initial, but minimal, increase in revenue in the 1st period which decreases in the 2nd time period, and decays to 0 by the 10th time period.

Lastly, the one standard deviation shock to the debt-to-GDP contemporaneously increases Eskom's debt from the 1st to the 3rd period. Thereafter it continues to increase

to the 10th horizon. The response of Eskom debt to the innovation of the debt-to-GDP ratio confirms that its debt was initially low after the state took on debt as its guarantee. However from the 3rd period, Eskom's debt increases as they become more indebted to the state (Julies, 2018).

EP: A one standard deviation shock to the electricity price has no impact on the debt-to-GDP ratio up to the 2nd time period. A minor decrease in the debt-to-GDP ratio is experience in the 3rd period, however it decays over the rest of the horizon.

A one standard deviation shock to the electricity price causes a positive shock to itself, with an increase from the 1st to the 3rd period. Thereafter, the electricity price decreases and is assumed to decay to 0 after the 10th time period.

Eskom's revenue has a similar response to the shock of the electricity price to itself. The revenue increases between the 1st and 2nd period. It increases again from the 2nd to the 4th period, and decays to zero by the 10th period. This shows that Eskom's revenue is only tied to increases in the electricity price (Lipczynski *et al.*, 2013).

Initially, Eskom's debt decreases between the 1st and 2nd time period; this happens after a shock to the electricity price because it could be able to remedy some debt instability. However, after the 2nd period, debt increases again until the 3rd time period. Over the rest of the horizon, it decays towards zero. This is an indication that price increases alone cannot solve Eskom's debt problems.

REV: A one standard deviation shock to Eskom's revenue creates a negative response from the debt-to-GDP ratio by causing it to increase from the 2nd time period. This is because it further deteriorates the national revenue fund. This is confirmed by Sunge *et al.*'s (2015) study, which found that the REH did not hold for Zimbabwe during the period from 1980 to 2013. They determined this by using an Error Correction Model (ECM) within an autoregressive distributed lag (ARDL) bounds testing approach, where total government debt was one of their variables.

A sharp increase is how the electricity price responds to a one standard deviation shock to Eskom's revenue. Again, this is owing to NERSA electricity increase applications.

Even though Eskom debt slightly decreases between the 2nd and 3rd time period, it increases again after the 3rd time period. This is because an increase in revenue, through equity injections for instance, means it is more indebted to the state.

ED: A one standard deviation shock to Eskom's debt decreases the ratio from the 2nd to the 5th period. Thereafter, it increases, but only slightly, throughout the horizon. This could be in instances when Eskom obtained a state-guaranteed loan from the World Bank. Initially, this did not have a negative impact on government debt/GDP, until after the 5th period when the state started to make repayments of the loan as a guarantee of that debt.

A one standard deviation shock to Eskom's debt increases the electricity price from the 1,5th period, however, from the 6th time period, it decreases throughout the entire horizon. This corroborates the narrative by Altman (2008:2) that Eskom applies for unacceptably high tariff increases in order to repay its debt faster.

A one standard deviation shock to Eskom's debt initially decreases Eskom's revenue. However, from the 3rd period it increases, and slowly decreases after the 6th period.

A one standard deviation shock of Eskom's debt to itself results in a decrease between the 1st and 2nd period, thereafter it increases up to the 3rd period. For the rest of the horizon it decays to 0 after the 10th period.

5.4.4 Forecast error variance decomposition analysis

A variable typically explains almost all of its forecast error variance at short horizons, and smaller portions at longer horizons. As previously discussed, the forecast error variance decomposition analysis is influenced by a method called Cholesky Ordering (Harris, 1995; Lütkepohl, 2006; Lütkepohl & Poskitt, 1991) and is usually analysed over a horizon of 20 periods. However, the study chose 10 periods due to the short sample size.

Table 5.6 below presents the variance decomposition analysis (Government debt/GDP) for the ten periods of the study.

Table 5.6: Variance decomposition analysis (GD/GDP)

For GD/GDP					
Period	S.E.	GD/GDP	EP	REV	ED
1	0.047397	100.0000	0.000000	0.000000	0.000000
2	0.087827	99.32659	0.410362	0.103406	0.159640
3	0.122620	97.21287	1.077720	0.686439	1.022972
4	0.149397	94.59126	2.143192	1.692304	1.573243
5	0.167862	91.90753	3.465280	2.924982	1.702208
6	0.179157	89.25106	4.944452	4.241474	1.563012
7	0.185297	86.63957	6.428047	5.434148	1.498232
8	0.188637	84.12694	7.733287	6.308906	1.830866
9	0.191264	81.87782	8.679665	6.727559	2.714958
10	0.194563	80.08269	9.166241	6.705858	4.045210

Cholesky Ordering: GD/GDP EP REV ED

Source: Author's computation from E-Views 9

For GD/GDP: A large proportion of the debt-to-GDP ratio is explained by itself. Up to the 5th time period, a shock to the ratio still explains itself at over 90%. In this decomposition analysis, the results confirm that the Ricardian Equivalence Hypothesis (REH) by Barro (1979) holds. The REH posits that government borrowing has no effect on the economy because individuals have myopic foresight and adjust their spending accordingly. This decomposition analysis supports studies by Mosikari and Eita (2017), as well as Nkalu *et al.* (2016), who found that the REH holds.

Up to 9.17% of the forecast error variance of the debt-to-GDP ratio is explained by the electricity price. This implies that much of the price increases at Eskom involve NERSA approving price adjustment applications from Eskom, which are later overseen by government through, for example, equity injections.

Revenue and Eskom Debt also explain some forecast error variance of government debt/GDP but to a far lower extent, with revenue at 6.7% and 4.05%, respectively.

Table 5.7 below presents the variance decomposition analysis for the electricity price.

Table 5.7: Variance decomposition analysis (EP)

For EP					
Period	S.E.	GD/GDP	EP	REV	ED
1	0.042637	4.874692	95.12531	0.000000	0.000000
2	0.075655	6.939856	87.68226	2.826115	2.551769
3	0.103810	6.308084	83.29662	5.019577	5.375723
4	0.127582	4.387011	80.50453	7.665924	7.442539
5	0.149219	3.858292	77.02074	10.40798	8.712982
6	0.172001	6.654030	70.81826	13.19992	9.327787
7	0.197966	12.64454	62.17863	15.83029	9.346542
8	0.227524	20.07234	52.76624	18.24340	8.918014
9	0.259715	27.15054	44.13215	20.50457	8.212734
10	0.293011	32.92000	36.99010	22.71312	7.376777

Cholesky Ordering: GD/GDP EP REV ED

Source: Author's computation from E-Views 9

For EP: The debt-to-GDP ratio explains 32.9% of the forecast error variance in the electricity price. This reiterates how the government has been increasing its own debt in order to appease price adjustment applications from Eskom (NERSA, 2017).

The fact that Eskom's revenue presents a 22.7% forecast error variance for the electricity price is another indication that revenues at Eskom are purely driven by the electricity price. This also bolsters the argument of unfair practices on the part of monopolies, where they manipulate the price to generate a higher revenue (Pindyck & Rubinfeld, 2013).

Eskom's debt explains less of the forecasting error of the electricity at only 7.38%.

Table 5.8 below presents the variance decomposition analysis for revenue.

Table 5.8: Variance decomposition analysis (REV)

For REV					
Period	S.E.	GD/GDP	EP	REV	ED
1	0.090597	0.005292	20.38199	79.61272	0.000000
2	0.118611	0.929064	32.97378	63.06286	3.034288
3	0.149160	0.918014	40.39720	56.58166	2.103130
4	0.174014	0.677174	44.71345	52.96222	1.647160
5	0.197800	1.362813	46.53697	50.81956	1.280655
6	0.222054	4.099302	45.78730	49.03042	1.082982
7	0.248819	9.001889	42.83342	47.12162	1.043077
8	0.278624	15.14694	38.52172	45.24899	1.082344
9	0.310881	21.33140	33.85197	43.68996	1.126668
10	0.344344	26.70258	29.50995	42.66586	1.121607

Cholesky Ordering: GD/GDP EP REV ED

Source: Author's computation from E-Views 9

For REV: The electricity price explains 29.51% of the forecast error variance in Eskom's revenue. This implies that Eskom has not been making tangible revenue from the efficient sale of electricity. This points to the fact that much of its revenue is increased by increasing electricity prices. This shows a great lack of productivity, according to the neoclassical theory of the firm (Snowdon & Vane, 2005; Varian, 2010).

In addition, 26.7% of its revenue is explained by the debt-to-GDP ratio, a further indication that government bailouts, state-guaranteed loans and NERSA applications form a large percentage of Eskom's revenue.

In this decomposition analysis, the study's stance by Keynes (1936) is supported. Keynes (1936) asserts that government borrowing should not be used to support public entities. Instead, it should be used for productive public capital expenditure. This is also the stance by Wheeler (1999) who has found that the REH does not hold, and government borrowing does have an adverse effect on the economy. Eskom debt has a lower forecast variance of 1.14%, which shows that it is not a significant influence on Eskom's revenue.

Table 5.9 below presents the variance decomposition analysis of Eskom debt.

Table 5.9: Variance decomposition analysis (ED)

For ED					
Period	S.E.	GD/GDP	EP	REV	ED
1	0.203308	3.10E-09	18.26727	0.751056	80.98167
2	0.226984	0.064329	20.13367	2.974872	76.82713
3	0.250600	0.718375	23.97790	2.930613	72.37311
4	0.272498	2.880471	26.42084	4.849852	65.84883
5	0.295868	6.651708	27.76144	6.607259	58.97959
6	0.323246	11.69276	27.46811	9.159260	51.67987
7	0.353393	17.18378	26.12769	11.85950	44.82903
8	0.385901	22.38467	24.20212	14.72217	38.69105
9	0.419342	26.83310	22.14234	17.57470	33.44986
10	0.452629	30.33573	20.19991	20.37192	29.09244

Cholesky Ordering: GD/GDP EP REV ED

Source: Author's computation from E-Views 9

ED: The forecast error variance for Eskom Debt is explained by the debt-to-GDP ratio, and it is up to 30.34%. The adverse effect of government borrowing is illuminated once more in this decomposition analysis.

The Modigliani and Miller (1958) paradigm confirms that Eskom is at liberty to secure internal financing and higher debt levels, not only because of hedging but because the state guarantees its debt.

Eskom's revenue and electricity price explain a large portion of Eskom debt's forecast error variance at 20.37% and 20.2% respectively.

The next section presents the results of the Error Correction Model.

5.5 LONG RUN EQUATIONS, RESIDUAL SERIES, AND MCKINNON RESPONSE SURFACE TESTING

The following sub-section will present the results for the Error Correction Model (ECM) of the current study. The results for the long run cointegrating equations will also be discussed. The section will also conduct a residual series test, McKinnon response surface testing, and a two-step Engle-Granger cointegration test. An ECM will be constructed, after which post-diagnostic tests will be run.

The model below is a base model used to construct ECM:

$$\frac{ED}{GD} = f \left(\frac{R}{EP}, STAFF, CR, DAR, GVA \right) \dots \dots \dots (5.2)$$

In the model above, the dependent variable was generated as Eskom debt as a proportion of government debt. The intention was to generate a variable that incorporates how much of government's debt is comprised of Eskom's debt.

Since GDP was included in the VAR, the study saw it fit to include GVA into the ECM to see if any supply side economic activities influence Eskom debt as a proportion of government debt. GVA is a sector-specific measure of economic activity, and Mohr (2016) notes that GVA is measured according to the primary, secondary and tertiary sectors of the economy.

This study has discussed the importance of Eskom as a monopoly supplier of electricity (Eberhard, 2004). Thus, all three sectors are dependent on the utility to supply their goods and services. Therefore, it would be useful to estimate these sectors' value added as it relates to Eskom debt relative to government debt.

Table 5.10 below presents the correlation matrix of the base model which will be used to construct the ECM. This is a covariance analysis which indicates the presence of multicollinearity amongst the variables. When a variable is highly correlated with one or more variables in a model, it suggests that it can be linearly predicted with a high degree of accuracy. However, the estimates of the model will be biased owing to the fact that one will not be able to completely isolate one estimate from another. Thus, a correlation matrix is important because it indicates which variables are suitable for inclusion in the model.

Table 5.10: The base model's correlation matrix

Correlation Probability	ED/GD	R/EP	STAFF	CR	DAR	GVA
ED/GD	1.000 -----					
R/EP	-0.831 (0.000)*	1.000 -----				
STAFF	0.796 (0.000)*	-0.459 (0.007)*	1.000 -----			
CR	-0.423 (0.014)*	0.602 (0.000)*	-0.512 (0.002)*	1.000		
DAR	0.004 (0.984)*	-0.481 (0.005)*	0.087 (0.630)*	-0.297 (0.094)*	1.000	
GVA	-0.472 (0.006)*	0.931 (0.000)*	-0.298 (0.092)*	0.554 (0.001)*	-0.549 (0.001)*	1.000

Source: Author's computation from E-Views 9

Where:

() indicates the p-values and

* Statistically significant at a 10% level

** Statistically significant at a 5% level

*** Statistically significant at a 1% level

Table 5.10 shows the correlation matrix of the ECM, while the p-values show the significance of the correlation between all the independent variables and their dependent variable (Steiger, 1980).

The null hypothesis is that there is no correlation, but when the p-value is statistically significant at either a 10%, 5%, or 1% level of significance, one can reject the null hypothesis in favour of the presence of correlation. According to the correlation matrix, all the variables have a significant correlation with the dependent variable, apart from the staff and the debt-to-assets ratio.

While the correlation matrix is important, for an ECM, the suitability of the model is generally determined by the significance of the variables when the long run equation is

estimated. This significance is determined by the variables' p-values. As such, the model will still include staff and the debt-to-assets ratio, and thereafter determine their significance.

5.5.1 Long run cointegrating equation of the base model

Table 5.11 presents the long run estimation of the following variables: Eskom debt as a proportion of government debt, revenue as a result of price changes, staff numbers, the current ratio, debt-to-assets ratio and GVA.

Table 5.11: Long run estimation of the base model

Dependent variable: ED_GD				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
R_EP	-0.075630	0.026394	-2.865401	0.0080
STAFF	0.080493	0.011745	6.853148	0.0000
CR	-0.006318	0.010814	-0.584219	0.5639
DAR	0.012579	0.021632	0.581523	0.5657
GVA	0.045983	0.016049	2.865246	0.0080
C	-0.141535	0.156993	-0.901537	0.3753
R-squared = 0.869	Adjusted R-squared: 0.85	F-statistic = 35.853, Prob(F-statistic) = 0.000	Durbin Watson Statistic = 2.074	Sample size = 33 Sample period = 1985 - 2017

Source: Author's computation from E-Views 9

$$\frac{ED}{GD} = -0.076 \frac{R}{EP} + 0.080STAFF - 0.006CR + 0.013DAR + 0.046GVA - 0.142..... (5.3)$$

Table 5.11 above shows the initial long run equation estimated for this model. While the current ratio and debt-to-assets are insignificant, their signs can still be interpreted as correct, according to risk management theory.

The following discussion is an interpretation of equation 5.3:

Revenue/Price (R_EP): A 1% increase in revenue due to an electricity price increase will decrease Eskom's debt as a proportion of government debt by 0.08%. According to the

neoclassical theory of the firm, an increase in price will increase revenue, with subsequently positive results on a company's balance sheet (Varian, 2010). This is line with the study by Yazdanfar and Öhman (2014), who posit that when a firm's financial performance is positive, the firm will have a subsequent decrease in debt.

STAFF: There is a positive relationship between the number of staff at Eskom and Eskom's debt as a proportion of government debt. Thus a 1% increase in staff numbers will increase Eskom's debt as a proportion of government debt by 0.08%. Snowdon and Vane (2005) have classified labour as one of the inputs of production, and it is therefore a measure of productivity. This implies that Eskom has not been productive, despite increasing their staff numbers. This indicates decreasing marginal returns to labour.

Current ratio (CR): There is a negative relationship between the current ratio and Eskom's debt as a proportion of government debt. This is the expected relationship, according to risk management theory. This implies that a 1% increase in the current ratio will decrease Eskom's debt as a proportion of government debt by 0.01%. According to Odalo (2016), as a company becomes more liquid, it has an increased ability to pay off its short term debt obligations. However, this is a significantly small effect. This is indicative of the fact that Eskom is in a poor financial state, and that it has been taking on far more debt than is feasible. This is supported by Modigliani and Miller (1958) who encourage high debt financing. The author of this study calculated Eskom's current ratio from its financial statements of 1985 – 2017 and found that the company is illiquid (Eskom Financial Statements, 1985 – 2017). This is to say that if it were to be sold, it would not be able to settle its short-term debts in 12 months (Odalo, 2016).

Debt-to-assets ratio (DAR): There is a positive relationship between the debt-to-assets ratio and Eskom's debt as a proportion of government debt, and according to risk management, this is the expected relationship. A 1% increase in the debt-to-assets ratio will increase Eskom's debt as a proportion of government debt by 0.013%. While this percentage may seem small or significant, it still holds that high leverage is associated with poor financial performance (Gurbuz *et al.*, 2016; Yazdanfar & Öhman, 2014). The author of this study also calculated the debt-to-assets ratio from Eskom's financial

statements of 1985 – 2017, and found that the company is insolvent (Eskom Financial Statements, 1985 – 2017).

Gross Value Added (GVA): It is surprising that there is a positive relationship between GVA and Eskom’s debt as a proportion of government debt. This is because it is expected that as the economy becomes more productive, Eskom’s productivity will also increase, thereby increasing its sales, and ultimately reducing its debt (Mohr 2016). Nevertheless, the interpretation is that a 1% increase in GVA will result in a 0.045% increase in Eskom’s debt as a proportion of government debt.

Table 5.12 below presents the results for a long run estimation of the base model. This table presents the long run estimates that include only significant variables.

Table 5.12: Long run estimation of the base model with significant variables

Dependent variable: ED_GD				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
R_EP	-0.071187	0.024310	-2.928308	0.0066
STAFF	0.084300	0.010393	8.111120	0.0000
GVA	0.039230	0.012632	3.105692	0.0042
C	-0.118780	0.148560	-0.799545	0.4305
R-squared = 0.866	Adjusted R-squared : 0.82	F-statistic = 62.452, Prob(F-statistic) = 0.000	Durbin Watson Statistic = 2.032	Sample size = 33 Sample period= 1985 - 2017

Source: Author’s computation from E-Views 9

$$\frac{ED}{GD} = -0.071 \frac{R}{EP} + 0.084STAFF + 0.039GVA - 0.119 \dots \dots \dots (5.4)$$

Table 5.12 depicts the output of the long run cointegrating equation, when only significant variables are considered. As a result, the base model has excluded the current ratio and debt-to-assets ratio. The interpretation of the coefficients only differs slightly. In equation 5.4, a 1% increase in revenue from an increase in the electricity will decrease Eskom’s debt as a proportion of government debt by 0.07%.

A 1% increase in staff numbers will increase Eskom’s debt as a proportion of government debt by 0.08%. And lastly, a one percent increase in GVA will increase Eskom’s debt as a proportion of government debt by 0.04%.

5.5.2 Tests for cointegration

This section presents the following tests for cointegration: residual series and McKinnon surface response testing.

5.5.2.1 Residual series

Table 5.13 presents the results of a unit root test on the residual series test.

Table 5.13: Residual series

Dependent variable: D(RESIDUAL)		
Null Hypothesis: RESIDUAL HAS A UNIT ROOT		
32 observations after adjustment (1986 – 2017)		
Augmented Dickey-Fuller Test		Prob.
Test Critical Values	-2.995796	0.0040
1% level	-2.639210	
5% level	-1.951687	
10% level	-1.610579	

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

Source: Author’s computation from E-Views 9

According to Asteriou and Hall (2016), one method of testing for cointegration is to test the residual series of the long run cointegrating equation. Table 5.13 shows the results for such a test which indicates the presence of cointegration.

However, in order to be more precise, the study has to conduct MacKinnon (1996) surface response testing which takes the number of parameters into consideration.

5.5.2.2 *McKinnon surface response testing*

$$C(1) = -4.9587 + (-22.140) * \left(\frac{1}{33}\right) + (-37.29) * \left(\frac{1}{33}\right)^2 = -5.66385$$

$$C(5) = -4.4185 + (-13.641) * \left(\frac{1}{33}\right) + (-21.16) * \left(\frac{1}{33}\right)^2 = -4.85129$$

$$C(10) = -4.1327 + (-10.638) * \left(\frac{1}{33}\right) + (-5.48) * \left(\frac{1}{33}\right)^2 = -4.46009$$

The results from the MacKinnon surface response testing show that -2.99576, the test statistic obtained from an ADF test of the residual series, is not the least negative of all these surface response tests. Hence, the study fails to reject the null hypothesis of no cointegration.

5.6 ENGLE-GRANGER COINTEGRATION TEST

This test was important for the study because it was the most reliable tool which could be used to detect cointegration. Table 5.14 presents the results of the two-step Engle-Granger cointegration test.

Table 5.14: Single equation cointegration test

Null Hypothesis: Series are not cointegrated				
33 observations (1985 -2017)				
Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
<i>ED_GD</i>	-5.543441	0.0055	-74.45036	0.0000
R_EP	-4.712966	0.0304	-26.14163	0.0298
STAFF	-4.835836	0.0238	-33.88528	0.0017
GVA	-4.211512	0.0789	-23.35636	0.0663

Source: Author's computation from E-Views 9

Since the residual series and surface response testing gave conflicting results, the study had to use a more robust test for cointegration. The study used the single equation ECM, hence, the Engle-Granger cointegration test was conducted on the long run cointegrating equation with significant variables, and it was established that cointegration exists. This was established from the significant tau and z statistics of Eskom debt as a proportion of government debt.

5.7 ERROR CORRECTION MODEL

Table 5.15 presents the results of the output for the study's ECM error correction model.

Table 5.15: Output for error correction model

Dependent variable: D(ED_GD)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(R_EP)	-0.056751	0.024191	-2.345981	0.0263
D(STAFF)	0.060630	0.018515	3.274626	0.0028
RESID01(-1)	-0.991468	0.209867	-4.724279	0.0001
C	0.001163	0.002023	0.574959	0.5699
R-squared = 0.487	Adjusted R-squared: 0.432	F-statistic = 8.873, Prob(F-statistic)= 0.000	Durbin Watson Statistic = 2.001	Sample size = 32 after adjustment Sample period = 1986 - 2017

Source: Author's computation from E-Views 9

$$\frac{\Delta ED}{GD} = -0.057 \frac{\Delta R}{EP} + 0.061 \Delta STAFF - 0.99 RESID(-1) + 0.001 \dots \dots \dots (5.5)$$

According to the ECM in equation 5.5, a 1% increase in the revenue as a result of an increase in the electricity price, will result in a 0.06% decrease in Eskom's debt as a proportion of government debt. This is again in line with the economic theory which states that an increase in price will increase a firm's revenue (Varian, 2010). Klimczak (2007) also notes that an improvement in the financial performance of a company will decrease its level of debt.

The positive relationship between staff numbers and Eskom's debt as a proportion of government debt is also unexpected, according to economic theory. This is because staff numbers are considered as labour, which is one of the inputs to production and should increase productivity (Pindyck & Rubinfeld, 2013).

The model indicates that a 1% increase in staff numbers will increase Eskom's debt as a proportion of government debt by 0.06%. Therefore, Eskom is experiencing decreasing marginal returns on labour.

The residual's coefficient is the error correction term in the ECM. It indicates the speed at which the previous time period's disequilibrium will adjust in the current time period (Engle & Granger, 1980). For the ECM above, the error correction term is quite high, which indicates that the economy will move back to its steady state at a fast speed of 99%. This is almost equal to one time period, which in the case of this study's observations is 1 year.

GVA was not included in the ECM, since the Engle and Granger cointegration test showed it was not cointegrated.

5.7.1 ECM post-estimation diagnostic tests

Table 5.16 presents the results of the post-estimation diagnostic tests which were performed on the ECM. They included the Jarque Bera test, Ramsey RESET test, Ljung-Box Q statistic test, Breusch-Godfrey LM test, ARCH LM test, and White's test.

The diagnostic tests are conducted to ensure that the residuals of the ECM are normally distributed, and to ensure that there is no misspecification, no serial correlation and no heteroskedasticity.

Table 5.16: Post-estimation diagnostic tests

Test	H ₀	Test Statistic	p-value	Conclusion
Jarque-Bera	Residuals are normally distributed	JB (2) = 3.047	0.218	Fail to reject H ₀ . Residuals are normally distributed
Ramsey RESET	No misspecification	LR(2) = 11.21314	0.0820	Fail to reject H ₀ . No misspecification at the 5% level of confidence
Ljung-Box Q	No serial correlation up to 6 th order	LB_Q(6) = 7.528	0.962	Fail to reject H ₀ . No serial correlation up to 6 th order
Breusch-Godfrey LM	No serial correlation up to second order	nR²(2) = 3.083381	0.2140	Fail to reject H ₀ . No serial correlation
ARCH LM	No ARCH	nR²(2) = 5.728375	0.0570	Fail to reject H ₀ . No ARCH
White	No heteroscedasticity of general form	nR²(no CT) = 4.286000	0.2322	Fail to reject H ₀ . No heteroscedasticity of general form

Source: Author's computation from E-Views 9

The post-estimation diagnostic tests in Table 5.16 indicate that the coefficients of this ECM can be trusted because its residuals are normally distributed, there is no heteroskedasticity, no autocorrelation and the model is correctly specified.

5.8 CONCLUSION

This chapter presented the graphical analysis, descriptive statistics and unit root tests of all the variables in the study. The chapter provided concise evidence from the VAR's impulse response functions and forecast variance decomposition analysis. According to the impulse response functions, a one standard deviation shock to the debt-to-GDP ratio has a minimal impact on the electricity price, Eskom's revenue and Eskom debt. This shows that an innovation to the debt-to-GDP ratio explains a large proportion of itself.

A one standard deviation shock to the electricity price has a positive response from Eskom's revenue and its debt. A one standard deviation shock to Eskom's revenue has

a positive response from the electricity price and Eskom's debt. A one standard deviation shock to Eskom's debt has a positive response from the electricity price and Eskom's revenue.

Up to 9.17% of the forecast error variance of the debt-to-GDP ratio is explained by the electricity price. The model also showed that the debt-to-GDP ratio explains 32.9% of the forecast error variance in the electricity price. The same model shows that the electricity price explains 29.51% of the forecast error variance in Eskom's revenue. In addition, 26.7% of its revenue is explained by the debt-to-GDP ratio. The forecast error variance for Eskom debt is explained by the debt to GDP ratio and it is up to 30.34%.

According to the ECM, a 1% increase in the revenue as a result of an increase in the electricity, will result in a 0.06% decrease in Eskom's debt as a proportion of government debt. The model indicates that a 1% increase in staff numbers will increase Eskom's debt as a proportion of government debt by 0.06%.

The error correction term is quite high, which indicates that the economy will move back to its steady state at a fast speed of 99%. This is almost equal to one time period, which in the case of this study's observations is 1 year.

In summary, this chapter has shown that the government has been increasing its own debt in order to appease price adjustment applications from Eskom. In addition, revenues at Eskom are purely driven by the electricity price, which means no tangible revenue has been earned from the efficient sale of electricity. This shows a great lack of productivity. This means much of its revenue is increases stems from increases electricity prices. Lastly, the debt-to-GDP ratio is adversely affected by Eskom's debt, since the state is a guarantee of their debt.

CHAPTER 6: CONCLUSION

6.1 INTRODUCTION

This chapter will present an overall summary of the study. The findings of the study are detailed in Section 6.2. Section 6.3 discusses the recommendations, while Section 6.4 outlines areas for further research.

6.2 FINDINGS FROM THE STUDY

This study had three objectives, namely:

1. To determine how the financial performance of Eskom affected government debt in the period from 1985 to 2017.
2. To determine how the financial performance of Eskom affected its own debt in the period from 1985 to 2017.
3. To identify the causes of the crisis at Eskom from a financial perspective.

6.2.1 Objective 1

To determine how the financial performance of Eskom affected government debt in the period from 1985 to 2017.

The study achieved this objective by estimating a VAR's impulse response functions and variance decomposition analysis. According to the impulse response functions, a one standard deviation shock to the debt-to-GDP ratio has a minimal impact on the electricity price, Eskom's revenue and Eskom debt. This shows that an innovation to the debt-to-GDP ratio is largely explained by itself.

A one standard deviation shock to the electricity price has a positive response from Eskom's revenue and its debt. A one standard deviation shock to Eskom's revenue has a positive response from the electricity price and Eskom's debt. A one standard deviation shock to Eskom's debt has a positive response from the electricity price and Eskom's revenue.

According to the forecast error variance decomposition analysis, up to 9.17% of the forecast error variance of the debt-to-GDP ratio is explained by the electricity price. The model also showed that the debt-to-GDP ratio explains 32.9% of the forecast error variance in the electricity price. The same model shows that the electricity price explains 29.51% of the forecast error variance in Eskom's revenue. In addition, 26.7% of its revenue is explained by the debt-to-GDP ratio. The forecast error variance for Eskom debt is explained by the debt-to-GDP ratio, and it is up to 30.34%.

It has been found that Eskom's poor financial performance is a strong contributor to public debt and that Eskom is one of the state's biggest contingent liabilities.

6.2.2 Objective 2

To determine how the financial performance of Eskom affected its own debt in the period from 1985 to 2017.

The study achieved this objective by estimating an ECM. The results of the ECM showed that a 1% increase in the revenue as a result of an increase in the electricity price, will result in a 0.06% decrease in Eskom's debt as a proportion of government debt.

A 1% increase in staff numbers will increase Eskom's debt as a proportion of government debt by 0.06%. Therefore, Eskom is experiencing decreasing marginal returns on labour.

The residual's coefficient is the error correction term in the ECM. It indicates the speed at which the previous time period's disequilibrium will adjust in the current time period (Engle & Granger, 1980). The error correction term is quite high, which indicates that the economy will move back to its steady state at a fast speed of 99%. This is almost equal to one time period, which in the case of this study's observations is 1 year.

6.2.3 Objective 3

To identify the causes of the crisis at Eskom from a financial perspective

The study has achieved this objective from the discussion of the background to the study, and the discussion of the theoretical and empirical literature. The study found that a low liquidity ratio, high debt-to assets ratio, and high company debt were the leading cause of Eskom's poor financial performance. However, what is important to note is that state

intervention also had a negative impact on Eskom's financials. In 1984, the De Villiers Commission prescribed to Eskom that they should not charge cost-reflective tariffs. This has contributed to Eskom's long-term debt instability due to not receiving adequate revenue with which to effectively maintain its generation capacity, transmission lines and other operations (Steyn, 2016; Kantor, 1988; Van der Heijden, 2013). Corruption has also had a strong influence on Eskom's poor financial status (Blom, 2018; Van der Heijden, 2013).

6.3 RECOMMENDATIONS

There are a few recommendations which can be made regarding Eskom's financial crisis.

- First, it is clear from the literature that of all the technologies associated with electricity generation, coal is the most expensive (GTAC, 2017). As such, it is important for Eskom to increase its research and development (R&D) in experimental research to discover new and cheaper ways to generate electricity. Mustapha, Kruss and Ralphs (2018) have found many concerning factors about SOEs and R&D. They found that many SOEs have been underspending on their budgets for R&D, have been recruiting significantly more technicians than scientists, and that they have been relying on institutions, such as the CSIR, to supply them with experimental research related to their respective industries. They recommend that the aforementioned oversights be addressed, and SOEs should search for local research expertise before employing international services, which was also found to be a major concern (Mustapha *et al.*, 2018).
- Secondly, privatisation is always a looming recommendation for SOEs and has been so for many decades. President Cyril Ramaphosa, in this year's State of The Nation Address (SONA) announced that there will be an unbundling of Eskom into three entities, namely, generation, transmission and distribution (Minaar, 2019). They are intended to be operated as separate businesses because of the urgent need for Eskom to function independently of the state. There is a strong suggestion of privatisation here and the literature has been pointing towards the introduction of IPPs for generation capacity. As such, there is uncertainty about employment at Eskom, and rightfully so because when Telkom was partially privatised, it shed jobs

from 61,000 employees to just 15,000 (Whitfield, 2019). However, privatisation appears to be a plausible solution, eventually.

- Lastly, an extension of this recommendation is fiscal consolidation. Since President Ramaphosa announced the unbundling of Eskom, he has alluded to a fiscal consolidation strategy for Eskom. Fiscal consolidations are usually applied to an entire economy in the form of a fiscal squeeze to decrease public debt (Labus & Labus, 2016). The conditions that warrant fiscal consolidation are usually high inflation, high public debt and sluggish growth (Tsibouris *et al.*, 2006). South Africa has the latter two, which is another reason for fiscal consolidation, apart from Eskom being a contingent liability. Moody's has also warned South Africa that Eskom has a large impact on the fiscal credibility of the state. Therefore, consolidation also appears to be a strong international recommendation (Paton, 2019). Nevertheless, President Ramaphosa announced during the SONA on 20 June 2019, that an immediate R230 billion is to be given to Eskom over the next 10 years because it cannot be allowed to fail (Bhengu, 2019).

6.4 AREAS FOR FURTHER RESEARCH

The model can be estimated using the budget deficit to obtain more robust results. Exchange rates, namely, the rand/dollar exchange rate can be included in the model to bolster the notion that some of Eskom's debt is denoted in foreign currency, especially that of the World Bank's. Although the electricity price contains the element of inflation, one could also include interest rates in order to have an isolated view of how interest rates behave in the model throughout the stipulated time period.

6.5 CONCLUSION

This study attempted to investigate and understand the extent to which Eskom bailouts have impacted on government debt. The study achieved this purpose through a systematic process of literature study and empirical testing. The Keynesian theory of government debt was used as a point of departure for the study and was used to justify the dependent variable in the model. The Modigliani-Miller paradigm, agency theory, stakeholder theory and new institutional economics approach were used to justify the

independent variables that were used in the study. The variables included Eskom's revenue, the electricity price, staff numbers, the current ratio, debt-to-assets ratio, GVA and GDP. Given the variables mentioned above, a VAR and ECM were used for the study's empirical analysis. The results of the study showed a significant relationship between the debt-to-GDP ratio, Eskom's revenue and Eskom's price.

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APPENDIX A: ETHICAL CLEARANCE CERTIFICATE



UNISA ECONOMICS ETHICS REVIEW COMMITTEE

Date 26/07/2019

Dear Ms Nkosi

**Decision: Ethics Approval from
2019 to 2022**

NHREC Registration # : (if
applicable)

ERC Reference # :
2019_DE_13(SD)_Ms L Nkosi

Name :Ms L Nkosi

Student # : 58537767

Staff # : 90233476

Researcher(s): Name Ms L Nkosi
Department of Economics
UNISA
nkosil@unisa, 0818447856

Supervisor (s): Prof. Z Robinson
robinz@unisa.ac.za , 0828355282

Working title of research:

The Relationship between SOEs and Government Debt: An Empirical Analysis of Eskom

Qualification: MCom Economics

Thank you for the application for research ethics clearance by the Unisa Economics Ethics Review Committee for the above mentioned research. Ethics approval is granted for 2019 – 2022.

The low risk application was expedited by the Economics Ethics Review Committee on 26th July 2019 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment. The decision was approved on 26th July 2019.

The proposed research may now commence with the provisions that:



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1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the Economics Committee.
3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.
7. No field work activities may continue after the expiry date (2024). Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

*The reference number **2019_DE_13_(SD)_Ms L Nkosi** should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Yours sincerely,



Signature

Chair of Economics ERC

E-mail: malefmr@unisa.ac.za

Tel: (012) 433-4641



Signature

Executive Dean : CEMS

E-mail:

Tel: (012) 429-6632

URERC 25.04.17 - Decision template (V2) - Approve

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