

An investigation into the relationship between debt sustainability and fiscal support for

Eskom



By

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Abstract

Eskom — South Africa’s state-owned electricity utility — is facing difficulty servicing the large debt obligations it has incurred over the last decade. This study investigated the trade-off between debt sustainability and the improvement in Eskom’s financial position. The empirical analysis is based on annual South African public finance data covering the period 2006/07 to 2016/17. The data analysis showed that the subsidies to the power utility did not detract from the underlying debt-sustainable public finance position. In fact, the analysis showed that the government subsidies improved Eskom’s valuation and profitability. Using simulations, a case was tested in which Eskom was provided with more subsidies instead of a loan guarantee, and the results showed that these subsidies would have further raised Eskom’s value while not harming the sustainable debt position of the public finances. Based on the results of this investigation it is recommended that the fiscal authorities employ the debt sustainability, guarantee valuation and cashflow techniques discussed in this report to evaluate whether issuance of a guarantee is aligned with the broader public finance objectives.

Declaration

TITLE OF DISSERTATION: An investigation into the relationship between debt sustainability and fiscal support for Eskom

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UNIVERSITY OF THE WITWATERSRAND

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NAME OF SUPERVISOR: Professor Tendai Gwatidzo

DATE: 24 October 2019

Declaration

I hereby declare that this is my own unaided work, the substance of or any part of which has not been submitted in the past or will be submitted in the future for a degree in to any university and that the information contained herein has not been obtained during my employment or working under the aegis of, any other person or organisation other than this university.

Name of Candidate

Signed

Signed this day of at Johannesburg

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1. Introduction

Eskom is an electricity utility that is owned by the South African government. Since the 2006/07 financial year, the utility has been engaged in a capital investment programme to add to its fleet of power stations and develop other infrastructure to meet South Africa's growing electricity demand (Sebitosi, 2010; Eskom, 2016). South Africa's development objective articulated in the 2012 National Development Plan (NDP) is to achieve an average annual economic growth rate of 5% in order to support other efforts to reduce poverty, inequality and unemployment (National Planning Commission, 2012). One strategy of the government to achieve higher economic growth is to increase capital expenditures on the infrastructure required to generate, transmit, and distribute electricity (Department of Energy, 2013).

The increase in Eskom's capital expenditures has largely been financed through a combination of increased borrowing and capital contributions from its sole shareholder, the South African government. The utility's overall debt levels have risen from R30 billion in 2005/06 to R367 billion in 2016/17 (Eskom, 2005; 2016). The South African government has contributed R91 billion to Eskom from the fiscus or public finances since 2009 (National Treasury, 2017). The South African government has committed to guaranteeing up to R350 billion of the debt that Eskom incurs on its capital expenditure programme (Ibid). In 2016/17 R218 billion of Eskom's debt had been guaranteed by the national government (Ibid).

An increase in debt is expected for a firm that is expanding its production capacity by investing in new capital stock. However, Eskom's capacity to service the debt it has incurred has severely diminished. This can be seen from the decline in the interest cover ratio, which measures whether a company is generating sufficient revenues in a year to service its interest payments (Ross et al. 2008). This figure is calculated by dividing a firm's profit — before it pays interest on debt or taxes — by the firm's annual interest expense. In Eskom's case, in 2005/06, this ratio was 3.87, which means that the utility could afford to service its interest commitment approximately four times over from the cash it was generating from its operations. By 2015/16, the ratio had fallen to 0.46, meaning that Eskom was only able to service approximately half of its interest costs in that year (Eskom, 2005; 2016).

A firm has to take on additional debt or request an infusion of capital from its shareholder to service debt when its cash interest cover falls below 1. This has been the case for Eskom in that it has increased its level of borrowing, as evidenced in its financial statements (Eskom, 2017). This leads to a further increase in the debt levels of the entity.

1.1 Statement of the problem

This study draws from the research by Myers and Majluf (1984) in which it is argued that a firm with a high debt burden will have to sacrifice important infrastructure investment projects. Eskom, it can be said, is a highly indebted firm. As such, it might not be able to execute on the energy investment targets set by the government in the NDP. It is, therefore, valid to ask if government guarantees were the best approach towards supporting Eskom's investment programme. The alternative would have been to provide the utility¹ with a direct subsidy in the form of allocations of money from the public finances.

The appropriateness of a subsidy has to be evaluated against the South African government's objective to stop the increase of the debt-to-Gross Domestic Product² (GDP) ratio (National Treasury, 2011). This increase began in 2008/09, and it has continued without pause (National Treasury, 2017). There are concerns that if this increase is not stopped, the public finances will no longer be sustainable, which means the government will no longer be able to afford the current levels of spending without defaulting on debt commitments (Ibid).

The purpose of this study was to test whether providing public finance subsidies to Eskom instead of a loan guarantee would have resulted in an outcome in which the government debt was unsustainable or unaffordable. In addition, the question arises whether the provision of public finance subsidies would have improved the value of the utility. By answering these questions, this investigation contributes to the development of a comprehensive framework for the funding of large capital investment programmes in the public sector.

It is shown in this investigation that the debt sustainability and economic value frameworks can complement one another in order to maximise value while achieving the government's public finance objectives.

¹ A utility is a provider of a service and usually operates as a monopoly provider. Examples include electricity companies, railway operators and telecommunications companies

² The debt-to-GDP ratio is measured by dividing the national government's debt stock by the nominal GDP.

1.2 Significance of the investigation

This study examined these preceding issues by drawing on research on debt or *public finance sustainability* as well as *firm valuation* as a theoretical framework. The significance of this study is twofold. First, this paper married two disparate strands of literature — debt sustainability and valuation — to show that they can be jointly used to evaluate public finance policy decisions. Second, it showed how the public finance question of whether it is better to finance infrastructure expenditure through deficit financing or through government guarantees could be answered within the debt sustainability framework.

1.3 Research questions and objectives

Given this background, the primary question of this study was: *What is the impact of subsidies to Eskom on the debt sustainability of the public finances and Eskom's financial performance? Further, how would public finance sustainability and enterprise value have changed had additional subsidies been provided to the utility between 2006/07 and 2016/17?* The main questions and objectives of the study are enumerated in Table 1.

Table 1: Research questions and objectives

Research Questions	Objectives
Did direct public finance subsidies provided to Eskom between 2006/07 and 2016/17 affect the utility's discounted cash flow (Value)?	To test if the public finance support Eskom received had a material impact on the utility's financial prospects
Did the subsidies provided to Eskom result in an unsustainable public finance position between 2006/07 and 2016/17?	To understand if the public finances would have been sustainable if support had not been provided to the utility
Would direct public finance support instead of a government guarantee facility to Eskom have resulted in an unsustainable public finance position?	To examine if government had scope to provide further subsidies to Eskom
Would direct public finance support to Eskom have resulted in positive discounted cash flow for Eskom?	To understand how additional subsidies to the utility would have affected its financial prospects

1.4 Organisation of the report

The rest of this report has six main sections following the introduction. Section two provides a review of the key policy decisions leading up to Eskom's capital investment programme that began in 2006/07. Section three provides the literature review that is divided into two subsections: a theoretical framework and a review of the empirical literature. The four main strands of literature covered in this section are *utility tariff setting theory*, *debt sustainability*, *guarantee valuation analysis*, and *economic value analysis*. Section four presents the research hypotheses. Section five describes the research methodology and data used to prove the

hypotheses, as well as pre and post-estimation tests to confirm the quality and validity of the data and the results. Section six presents and discusses the results of the study. The seventh section concludes and presents implications for policymaking and options for further research.

2. History of Eskom investment

The purpose of this section is to provide a background to the rationale behind Eskom's investment decisions, the financial implications for the utility and the development implications for the electricity sector. In this section, the government policies that partially explain the utility's weak financial position are discussed.

This section has three main parts:

- (i) A review of energy policy choices, drawn largely from the 1998 White Paper on South Africa's energy policy published by the Department of Minerals and Energy (Department of Minerals and Energy, 1998) and focusing on the period after the White Paper was published;
- (ii) A review of the financial choices made concerning the funding of new electricity infrastructure; and
- (iii) A discussion about the change in Eskom's financial position over the period 2006/07 to 2016/17.

2.1 Energy policy review: the rationale for electricity infrastructure investment

In 1990, Eskom projected that by the year 2000 electricity demand in South Africa would outpace electricity supply (Eskom, 1990). Consequently, the utility would need to invest in new infrastructure during the 1990s (Ibid). These plans were delayed and then cancelled because the economy grew at a slower pace than was initially forecast (Eskom, 1992; Newberry and Eberhard, 2008). Instead, the utility's investment plans shifted towards improving transmission and distribution infrastructure in order to increase the number of households with an electricity connection (Department of Minerals and Energy, 1998). This contributed to the growth in electricity demand by connecting 5.8 million households to the electricity grid (Department of Energy, 2014). Average economic growth between 1998 and 2007 accelerated, compared to the average between 1980 and 2000 (Burger and Calitz, 2015).

This contributed to the strong growth of electricity demand between 1998 and 2009, as shown in Figure 3.

2.2 The evolution of energy policy leading up to Eskom's new build programme

In 1998, the Department of Minerals and Energy published The *White Paper on the Energy Policy of the Republic of South Africa* (referred to henceforth as the *1998 Energy White Paper*). The document is the forerunner to later energy sector policy documents such as the 2010 Integrated Resources Plan (IRP). The 1998 Energy White Paper has been the guiding framework on which energy policy decisions are based.

Two important points are made in the 1998 Energy White Paper about electricity policy and Eskom. The first point is the forecast that in the year 2007, electricity demand would exceed supply, which meant that investment in electricity generation infrastructure would be required. The second point is the argument that in order to maintain South Africa's competitive advantage in global trade, it is important that electricity tariffs remain low. These two points imply that Eskom would be required to make investments to increase the amount of energy generation infrastructure and take initiatives to limit demand. At the same time, the utility would be limited in its ability to use the tariff to raise equity to finance the investments or to encourage efficient energy usage.

Eskom (2017) argues that this policy choice has encouraged energy-inefficient consumption by industrial customers, as they do not bear the full cost of electricity. This is reflected by the energy intensity of South African production (Sebitosi, 2010; Kohler, 2014). The effect of this type of inefficient usage has been to accelerate the need for Eskom to begin building new electricity generation power plants in order to meet growing electricity demand (Ibid).

The 1998 Energy White Paper assumed that a large proportion of the electricity infrastructure required over the next decade would be filled by the entry of private sector producers into the electricity sector. However, Eskom's dominant position has prevented this. Bayliss (2008) and Baker (2011) argue that this represents a market failure caused by Eskom's electricity tariff being too low for private sector generators to compete and break even. Government's intervention to fix this failure was to develop an Independent Systems Market Operator (ISMO) (National Planning Commission, 2012). The ISMO would have had overall responsibility for running the transmission network of the electricity sector and coordinate how the various electricity producers get fair access to the electricity transmission network

(Department of Minerals and Energy, 1998). Essentially, ISMO would be a state-owned transmission utility that buys electricity from several firms that generate electricity.

The challenge with establishing an ISMO is that it would end Eskom's dual role in the energy sector as a producer and a market operator. This is because it would necessitate the unbundling of Eskom into at least two separate institutions: a generation unit and a transmission unit (National Planning Commission, 2012). The generation unit of Eskom, as the name suggests, would be responsible for the production of energy and would be one of several firms in the electricity generation market trying to win market share (Ibid). The transmission unit would be the ISMO and remain a monopoly in the transmission sub-segment of the electricity market. The role of the ISMO would be to purchase the electricity from the cheapest and most reliable producers in the sector. In 2015, the South African governing party, the African National Congress, argued for the abandonment of the ISMO proposal because of Eskom's weak financial position (Paton, 2015). The party argued that the utility would not be able to service the large debt obligations it had incurred over the last 10 years if it no longer had its monopoly position in the electricity sector (Ibid). This is because it would struggle to generate sufficient revenue to service the debt in a market where electricity tariffs are falling due to competition. A review of Eskom's annual reports between the financial years 2012/13 and 2016/17 suggests that there is merit to this argument. The transmission division of Eskom consistently generates a net-profit margin in excess of 20% of revenue. This compared to the at most 16% net profit margin from Eskom's generation division. The unbundling of Eskom that the ISMO would necessitate would result in Eskom losing this more profitable business unit.

In 2013, the legislation that had to be passed in order to begin the process of establishing the ISMO was withdrawn from consideration by Parliament (Styan, 2015). Khan et al. (2016) argue that the abandonment of the ISMO was done in order to protect Eskom's financial position. If this is the case, it means South Africa has sacrificed the potential investment that would have come with the reform of the electricity sector in order to protect Eskom. The analysis done by South Africa's Department of Energy for the IRP shows that South Africa requires cumulative investment spending of R8 trillion on electricity generation infrastructure until 2050 to meet the forecast future energy demand (Department of Energy, 2011). A significant proportion of these investments would be made by private sector producers. This is the most

significant example of Eskom's weak financial position affecting the development of South Africa's electricity sector and the national development goals articulated in the 2012 NDP.

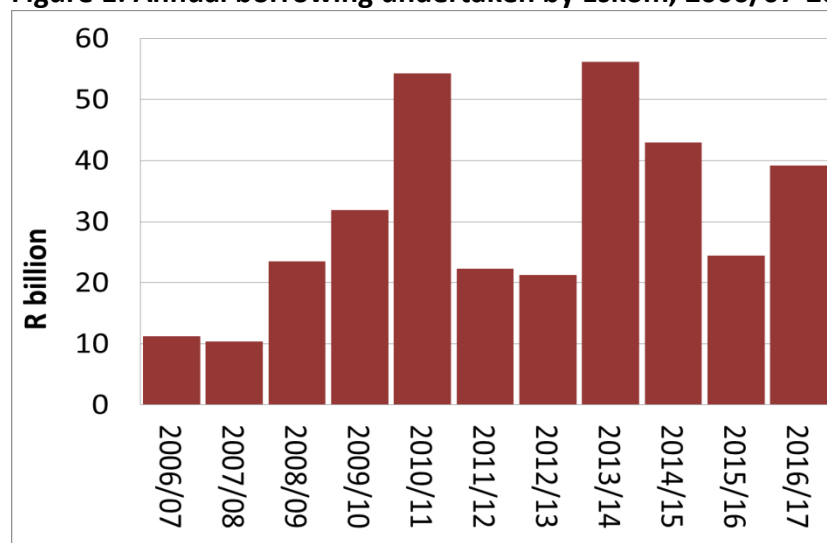
2.3 New investment in the period 2006/07 onwards

The Cabinet of South Africa announced in 2004 that Eskom would invest in additional electricity generation infrastructure in light of growing electricity demand (GCIS, 2004; Eberhard et al. 2014). The decision was also motivated by the fact that the private sector had not made the investments in electricity generation infrastructure as envisaged in the 1998 Energy White Paper (Ibid).

Government policy documents during the period leading up to the construction of Eskom's new infrastructure place great emphasis on the utility financing the build programme independently of public finances. The 1998 Energy White Paper emphasises creating the conditions to attract "private finance" for new energy projects (Department of Minerals and Energy, 1998, p. 21.). The National Treasury (2011, p. 92) argues that state-owned companies (SOCs) are expected to fund capital investments on the "strength of their own balance sheets". Similarly, it is argued in the NDP that Eskom should borrow to finance its build programme and not rely on public finance resources (National Planning Commission, 2012). The NDP does, however, see a role for public finance support to Eskom in the form of guarantees in order to support the investment programme (Ibid). The explicit assumption made in the NDP is that Eskom will recoup its investment cost through the electricity tariff paid by users. Eskom (2015) argues that the electricity regulator has been unwilling to grant tariff increases that would allow the utility to cover the investment costs it incurs.

In 2006/07, debt accounted for 37% of Eskom's capital structure, and equity accounted for 63% (Bloomberg, 2018). As a result of the sharp increase in borrowing by Eskom, the share of debt in Eskom's capital structure increased to 68% and the rest was made up by equity in the 2016/17 financial year (Ibid). Figure 1 below shows the increase in borrowing that took place at Eskom beginning in the 2006/07 financial year.

Figure 1: Annual borrowing undertaken by Eskom, 2006/07-2016/17



Source: Various Eskom annual financial statements

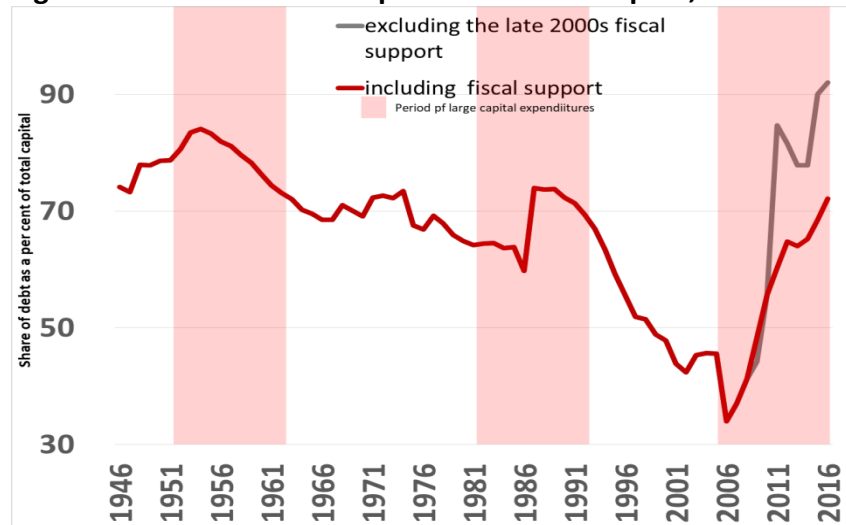
A review of Eskom's annual reports from 1946 to 2016 illustrates three points. First, Eskom's financial position in the period leading up to 2006/07 was unusually strong in that the debt held by the utility was at a post-war record low of under 40%. Burger et al. (2015) argue that this outcome is symptomatic of low levels of public-sector investment in the post-1994 period. This was part of government policy at the time to reduce the overall public sector debt and interest payments (Burger et al. 2015).

The second insight is that during periods of capital investment, Eskom's debt as a proportion of total capital structure tends to rise to about 70 % on average, as shown in Figure 2. This means that Eskom's debt as a proportion of the total capital structure at 68% in 2016/17 is largely in line with the historical average. However, it should be noted that this includes the R91 billion which was allocated to Eskom from the public finances over the period. If this allocation were to be excluded, then proportionally Eskom's debt would account for 90% of the utility's capital structure.

The third insight is that it can be concluded that it was not unreasonable for the government to expect Eskom to finance the new build programme through debt. This is because debt has on average made up 60% of Eskom's capital structure. However, this expectation ignores two important regulatory changes that have taken place since Eskom's last large capital investment programme. The first was a regulatory change to exclude the replacement costs of infrastructure from the tariff which the utility charges its consumers (Kantor, 1988). The second significant change was that the utility no longer had the power to set electricity tariffs

unilaterally (Steyn, 2006; Newberry and Eberhard, 2008). These two factors mean that the utility could not automatically expect to generate sufficient returns to service its debt obligations. This would now be at the discretion of an independent regulator, the National Energy Regulator of South Africa (NERSA). The result has been that the average tariff increase awarded by the National Energy Regulator of South Africa, according to Eskom, has been below the level required to cover capital expenditures (Eskom, 2015).

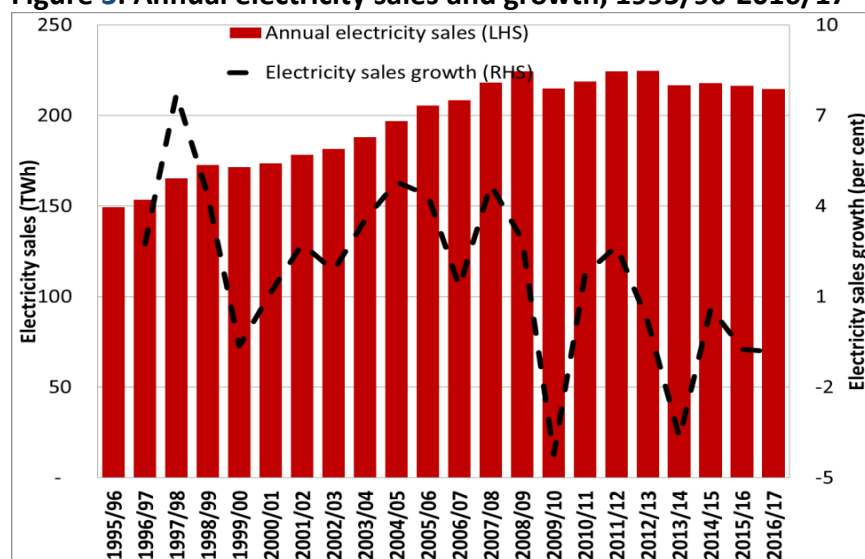
Figure 2: Share of debt as a per cent of total capital, 1946-2016



Source: Author's own calculations using various Eskom financial statements

The policy decisions on tariffs could partly explain why profits (a third source of capital for a firm) declined between 2006/07 and 2016/17. During this period, the utility's after-tax profit grew at an annual average pace of 1.2% (Bloomberg, 2018). In the preceding decade, Eskom's profit grew at an average rate of 9% (Ibid). The slowdown in profit growth has been compounded by the costs incurred due to the capital investment program. This also includes the costs of servicing the debt that Eskom has taken on in the period (Ibid). An additional factor is that annual electricity sales growth has been flat and at times negative since 2008, as seen in Figure 3.

Figure 3: Annual electricity sales and growth, 1995/96-2016/17



Source: author's calculations using various Eskom annual reports

2.4 Government support to Eskom

In 2009, the South African government entered into a Guarantee Framework Agreement (GFA) with Eskom (Bowman-Gilfillan, 2012). The value of this guarantee agreement is R350 billion (Ibid). This is a contractual agreement between the national government, Eskom, and the utility's debt holders that if Eskom defaults on interest or debt principal payments, the national government will assume the debt on the utility's behalf and repay the outstanding principal and interest (National Treasury, 2017). From the perspective of the utility's lenders, a loan guarantee is a form of collateral, which can be used to reduce the loss to the lender if Eskom defaults. This reduces the risk of lending to Eskom, and so the lenders should be willing to reduce the interest rate they charge for lending to Eskom. From the utility's perspective, guaranteed debt is desirable because it is cheaper to service than unguaranteed debt. In effect, a loan guarantee is an interest subsidy from the public finances.

The government has also provided direct support to Eskom over the period. This has mainly been through a R60 billion subordinated loan³ disbursed between 2009/10 and 2011/12 (National Treasury, 2011). The entire subordinated loan was subsequently converted to equity in the 2015/16 financial year (National Treasury, 2017). This conversion means that Eskom was no longer expected to repay the loan. The government provided a further R23 billion subsidy to the utility in 2015/16 (Ibid).

³ A subordinated loan agreement means that the lender is the last to be compensated in the event of a wind-down of Eskom; as such, the loan is similar to equity in that they are paid after senior lenders have been fully compensated for any losses incurred in the dissolution of Eskom.

2.5 Implications for the direction of future energy policy

The above examination of the changes to Eskom's capital structure shows that in keeping with the government's policy, Eskom has indeed largely funded its new build programme on the "strength of its own balance sheet" (National Treasury, 2011, p. 92). It has been shown that this approach has not been without its downsides. One problem is that in the short term, Eskom has been over extended to the point that there is uncertainty about its ability to service the debt obligations it has incurred over the past decade. This uncertainty is worsened by the possibility that the tariff increases granted by NERSA will be below what Eskom applies for (Eskom, 2015). The National Treasury (2018) notes the risk that Eskom forecasts that electricity sales growth will be flat over 2018 to 2023. The National Treasury argues that there is a further risk that higher electricity tariffs will reduce electricity demand and revenue in turn, further undermining Eskom's ability to service its debt obligations (National Treasury, 2018).

From this section, it can be seen that Eskom's deteriorating financial position is a major hurdle towards the implementation of the targets set out in the 2010 and 2013 Integrated Resources Plan and the National Development Plan. The key example of this has been the abandonment of the implementation of the ISMO and the implications of this for investment in the electricity sector.

In the sections that follow, what was tested for was whether direct fiscal support would have been a better financial arrangement for both Eskom and the South African public finances. This is opposed to the reality over the past 10 years where the support provided to Eskom by the government has primarily been in the form of loan guarantees.

3. Literature review

Based on the discussion in the first two sections, this literature review covers three themes of academic research. First is a brief discussion about the role of electricity tariffs in the funding of the operations and capital investments of public electric utilities. Next is a review of the literature on the sustainability of public finances. Finally, literature that covers capital structure, profitability, and value creation as it relates to public utilities is considered.

This review is structured into three major parts. The first is a theoretical review intended to position this investigation; it helped to build the research methodology, which is discussed in

section 4. The second part of this review is a discussion of the empirical studies which have the main themes and questions of this investigation as their subject. The third part of the review is to identify the research gaps that this investigation aimed to fill.

3.1 Theoretical Framework

The theoretical framework of this investigation is structured around the principles of public finance management in South Africa. These are *counter-cyclicity*, *inter-generational equity* and *fiscal or debt sustainability* (National Treasury, 2011). The focus of this investigation is the latter two. In the subsections that follow, the academic literature to test for adherence to these principles is laid out.

The notion that public finances should behave counter-cyclically has a long history in macroeconomic theory. According to this principle, fiscal policy should be used to smooth the business cycle through higher spending when aggregate demand falls and lower spending when aggregate demand rises (Keynes, 1936). Inter-generational equity is the idea that all generations who enjoy a public good should share in its costs by contributing to its financing through the taxation system (Calitz and Fourie, 2007). Debt sustainability is the condition that a government will have sufficient future tax revenue to repay the debt it incurs and the associated interest payments (Wyplosz, 2007).

3.1.1 Aspects of financial management of public utilities

Before taking a deep-dive into the issue of firm valuation, it is important to discuss some of the unique aspects of the pricing and budgeting of electricity utilities. In this regard, Hotelling (1938) makes a seminal contribution by arguing that public utilities should apply marginal cost pricing. Marginal cost pricing is the concept that the price of a unit of service should reflect the cost of producing that unit of service. According to the author, this type of pricing for utilities should produce an allocatively efficient outcome. What this means is that all consumers whose willingness to pay is above the price set by the utility will have access to the utility's product. Put differently, the utility will be able to service the maximum number of users without making a loss if it sets tariffs equal to marginal cost.

Houthakker (1951) builds upon this principle, adding that utility tariffs should take into account that as a power station produces electricity, the usefulness of its capital stock diminishes to a point where it is no longer useable. This is known as depreciation. After some time, a power station has to be replaced. This cost of replacement has to be reflected in the

tariff; this is the long-run marginal cost of electricity. In order to account for this long-run marginal cost, the electricity tariff should be structured in to two parts: a fixed access charge to cover the cost of replacement and a charge which accounts for the cost of production of electricity (the marginal cost). The replacement charge of the electricity tariff is the power utility's profit in the short-term (Houthakker, 1951). It is from this profit that the utility generates the equity required to make replacement or expansion investments in the long term (Ibid).

The theory laid out by Marshall (1895) and Modigliani and Miller (1958; 1963) of economic profit and discounted cash flow can be used to evaluate if a utility's managers adhere to this principle of marginal cost pricing. These are discussed next.

3.1.2 The principles of valuation, economic profit and inter-generational equity

Valuation and economic profit analysis, discussed in this subsection, can be used to show if the utility applies the marginal cost pricing principles discussed previously. Economic profit analysis can also be used to show whether Eskom contributes to increasing inter-generational equity (Koller et al. 2005). This is because, as the theory below shows, a profitable investment necessarily increases the value of a firm (Modigliani and Miller, 1958). At the same time, profit belongs to the shareholders of a firm. As such, profitable public investments contribute to inter-generational equity since profit is an equity item.

One approach to assessing inter-generational equity is to add all public sector liabilities and assets to the national debt stock (Easterly, 1999). Equity would be the difference between all the government liabilities and assets (Kolitz et al. 2009). Liabilities are future outflows of a firm, that is, they are future costs that a firm will have to pay (Ibid). Assets, on the other hand, are incomes that a firm will earn in the future (Ibid). This is known as the public sector balance sheet approach to estimating inter-generational equity.

Pritchett (2000) argues that the balance sheet approach is flawed for two reasons. First, it only captures a single period in time (usually a year) and does not capture the value changes over time. This is insufficient to measure inter-generational equity since public infrastructure assets have very long lives. Second, the author argues, balance sheet values reflect what was spent on the acquisition of an asset. This leads to misleading conclusions when the assets of

public utilities are plagued by cost overruns, significant finance costs and capitalised interest payments⁴.

To get around this challenge, Pritchett (2000) proposes that public assets be valued according to the net cash flow they generate throughout their useful life. The foundation of this idea traces as far back as Marshall (1895), who contributes to the concept of value by making a distinction between *normal profit* and an *economic profit*. A normal profit is the difference between a firm's revenue and its operational expenses. This is distinct from an *economic profit*, which is the normal profit after deducting for the cost of capital (Marshall, 1895). This takes into account that a firm expends an amount of capital to produce goods (also known as opportunity cost). The use of capital incurs a depreciation cost because the production process runs down capital assets to the point that they are no longer useable. However, depreciation is not a cash cost; a firm is only truly profitable in the long run if it returns sufficient cash to compensate for this depreciation of capital. Such a firm is said to earn an economic profit (Mas-Colell et al. 1995).

Modigliani and Miller (1958) build on Marshall's contribution by showing that the value generated by a firm can be measured by discounting the cash generated over the firm's lifetime by the cost of capital. This, according to the authors, is known as the valuation of the firm (also referred to as value) using discounted cashflow analysis.

The notion of value makes operational the concept of economic profit because the present value of the profit generated by a firm is calculated by taking into account the capital or opportunity cost a firm incurs (Modigliani and Miller, 1958). Value means that the firm will generate at least enough cash flow not only to cover operational expenses but also to repay the lenders and shareholders who contributed the capital the firm uses to produce output. Value can be assessed with the discounted cash flows approach.

It is apparent from these definitions that value and equity are equivalent. If an investment decision generates value (or an economic profit), then by definition it contributes to equity in that it generates a normal profit sufficient to compensate for the depreciation of the firm's capital stock. Value can also be used as a more precise measure to evaluate whether a fiscal

⁴ Capitalised interest is an accounting concept which treats the interest obligations on a debt incurred in the construction of an asset as an asset. This value is then reduced over time once the asset is operational.

decision is generating inter-generational equity since it takes into account the long-run capital depreciation costs. An investment decision is shown to generate value and hence contribute to inter-generational equity if the present value of its incomes exceeds the present value of costs. Inter-generational equity can, therefore, be assessed by showing that public-sector investment decisions are contributing to a stock of assets which generate positive economic profit and value over the long-run as per the guidance of Marshall (1895), Modigliani and Miller (1958; 1963) and Pritchett (2000).

3.1.2.1 How is value created?

So far, this theoretical discussion about intergenerational equity and value has shown that value is created when a firm undertakes an economically profitable investment. The second issue of concern in the literature is whether a firm's capital structure is itself a source of value. This is a relevant concern in this investigation because a further subsidy from the public finances to Eskom would have changed the utility's capital structure. An increased subsidy would have reduced the amount of debt accumulated by the utility through borrowing.

Modigliani and Miller (1958; 1963) argue that the value of a firm is independent of its choice to finance its investments through debt or equity. This means that a firm should be indifferent between the choice of funding its capital investments through either debt or equity. This is because a firm with a low level of debt will have lower interest payments and therefore generate high profits and high return for investors (Modigliani and Miller, 1958). At the same time, high profits indicate that a firm has a high capacity to repay the debt that it incurs and therefore the cost of debt at low levels of debt will be low (Ibid). However, as the firm increases its level of this relatively cheap debt, it reduces the return that shareholders earn and increases its cost of debt, which means that the firm value is unchanged. Therefore, the only determinant of value, according to the authors, is that the financial return on a project is below the overall cost of capital of a firm (Ibid). If this is the case, then the firm should invest in a project (Ibid). This can be interpreted to mean that the most important criterion is for a firm to reduce its cost of capital by finding the cheapest source of funding in order to maximise value. This means that at the point where the cost of capital for new investment projects exceeded their expected return, Eskom should have stopped the investments. However, the investments were a policy priority for South Africa; a decision to stop investing would have been impractical.

Modigliani and Miller (1963) later argue that capital structure is, however, an important consideration for value generation when taxes are involved. This is because a firm's tax liability is calculated on profit after deducting the interest obligations generated by its debt stock. That is, the amount of tax paid by the firm will be reduced by the value of interest paid by the firm. A firm will choose debt finance because it reduces the amount of tax a firm pays. This is known as a tax shield. Modigliani and Miller (1966) show that in the case of firms whose tariffs are regulated, the presence of the tax shield does not affect the choice to finance from debt or equity. This is because the additional profit that the utility makes from the tax shield will be passed back to the consumer in the form of lower tariffs. In the case of Eskom, this argument is at least partially true. The *allowable revenue* formula from NERSA (2006) used to calculate the electricity tariff includes a separate line item for forecast tax payments by Eskom. That is, the tariff compensates Eskom with higher revenues should they expect tax expenses to increase in the future. It also penalises Eskom with lower tariffs should the utility's tax expense decrease. However, as Eskom (2017) clarifies, the utility's return on assets is calculated on a pre-tax basis. The weighted cost of capital (WACC)⁵ is not adjusted for the tax benefit of debt. Therefore, Eskom earns a higher return on its assets (because the return on assets is calculated using WACC) than would be the case if the methodology were strictly applied. It can be argued therefore that the absolute level of debt should not increase the utility's cash flows or value; however, the relative cost of debt does provide a benefit to Eskom in the form of higher cash by raising the return Eskom makes on its assets.

Given this discussion of value and capital structure, a key question to ask is whether shareholder contributions would make a difference concerning the value and economic profit generated by the utility. The framework laid out above provides the tools to answer this question. A second question is whether such an intervention can be undertaken without violating the fiscal objective of debt sustainability. This investigation turns to this question next.

3.1.3 Debt sustainability theory

The assessment of debt sustainability rests on the notion that when a government's expenditure exceeds revenue, a deficit is incurred (Wyplosz, 2007). This deficit is filled through borrowing (also known as debt accumulation). A deficit creates two types of

⁵ WACC is the weighted average cost to fund the firm from debt or equity based on the relative reliance on either financing option.

obligations: a debt-principal⁶ obligation and an interest obligation. If the government does not have sufficient tax revenue on hand to repay the interest and principal when each falls due, it has to fill the gap by making even more borrowing (Ibid). This is known as a budget deficit. Therefore, a government's present-day stock of debt is made up of past debts and interest due on those past debts as well as any new borrowing due to present day deficits (Fischer and Easterly, 1990). When a government is running a primary deficit, it is adding to the stock of public debt (Ibid).

A government's finances are constrained by the fact that it cannot borrow to repay interest and debt-principal forever. At some point in time, all the lenders to the government will expect to be repaid (Neck and Sturm, 2008; Wyplosz, 2007). In the literature, this is known as the *inter-temporal budget constraint*. What this means is that the government will have to earn more revenue than it spends in order to service all its present-day debt and interest obligations (Wyplosz, 2007). When a government collects more tax revenue than it spends, it is said to be running a primary surplus. The government uses the surplus to pay down debt and interest obligations (Ibid). The greater the present-day stock of debt a government holds, the larger primary surpluses needed to pay down the debt in future.

If it can be shown that the discounted value of future primary surpluses is greater than the present-day value of the public debt, then the government is said to be solvent, and the public debt is defined as sustainable (International Monetary Fund, 2011; 2013). Public debt in the literature is considered sustainable if the public finance authorities can be shown to adhere to the intertemporal budget constraint.

Bohn (1998) contributes by proposing an operational test for adherence to the inter-temporal budget constraint condition. This is known as the fiscal reaction function. A fiscal reaction function tests the response of the primary surplus to a change in the debt-to-GDP ratio. Specifically, it must be shown that there is a positive relationship between a change in the primary surplus and the public debt if the public finances are sustainable (Bohn, 1998; Burger et al. 2012).

⁶ Debt principal is the actual amount that the firm borrows. This is also known as the redemption value of debt.

3.1.4 Valuing existing support to Eskom and measuring the cost of default

To conclude, it is important to emphasise that the South African government has provided financial support for Eskom's investment programme in the form of government guarantees in addition to direct subsidies. Given this context, it is important to ask the question about the impact the decision to provide guarantees has had on debt sustainability. Specifically, would a debt sustainable outcome have been achieved if direct subsidies were provided to the utility instead of guarantees?

Estimating the size and the impact of the government subsidies to Eskom on debt sustainability and inter-generational equity is relatively straightforward since it is the amount that was transferred from the public finances. Estimating the impact of guaranteed support on the public finances is complicated because guarantees do not result in a cash outflow (Mody and Patro, 1996). A firm that receives a guarantee will not utilise the guarantee if it can pay the guaranteed debt obligations. This means that a guarantee will create a debt obligation for the public finances, but the issuing of the guarantee will not have an impact on the deficit (Baldwin et al. 1983; Lewis and MacKinnon, 1987). This may not be an appropriate policy choice because although guarantees do not necessarily create debt, they nevertheless increase the liabilities of the government (Baldwin et al. 1983; Biggs, 1996). If, in the future, the guaranteed entity fails to service its obligations, the guarantee will be triggered or called upon, and there will be an outflow of resources from the public finances (Mody and Patro, 1996).

The valuation of loan guarantees is a subset of the literature on options pricing. This is an area of research that draws upon the work of Black and Scholes (1973) and Merton (1977). An option is a financial instrument that gives its holder the right to buy a financial security (usually a stock) on a specific date at a pre-determined price (Merton, 1977). The option will only be used if the price of the underlying asset is below the exercise price of the option (Ibid). According to Black and Scholes (1973), this principle can be used to value any liability of a firm. This is because liabilities are claims or outflows, which can only be paid if the firm generates sufficient cash from operations or from selling assets that it owns. Like a traditional option, their exercisability (and hence their value) is contingent on the price of the underlying stock (Black and Scholes, 1973). Merton (1977) argues that guarantees also exhibit this feature of contingency; a guarantee will only be exercised contingent on the firm not having sufficient assets to make good on the guaranteed obligation.

3.1.5 The theoretical framework for this study

The two main theoretical approaches of debt sustainability and valuation analysis that have been outlined in this section are tied together by the concept of valuation. Together these two approaches contribute to a better understanding of cash flows generated by either public finance decisions or decisions on the capital structure of a utility. In this way, these theoretical approaches are appropriate to answer the core research focus of this study: an evaluation of the impact (in terms of cash flow) of a decision to provide Eskom with a government guarantee as opposed to subsidising the entity from the public finances. This is at the same time recognising It is acknowledged that a decision to provide Eskom with a guarantee could worsen its valuation; on the other hand, a subsidy could worsen the government's own debt metrics.

From this theoretical review, it can be concluded that the basic approach of this study is to determine the subsidy that would have flowed to Eskom by using the options pricing approach. This subsidy would replace the R350 billion government loan guarantee. The appropriateness of such a policy decision can be evaluated by testing whether it results in an outcome that is debt sustainable. Similarly, would this policy choice produce a better valuation and economic profit outcome for Eskom than providing a guarantee? This then gives a set of figures which help to determine whether the choice to provide a subsidy instead of a guarantee is in line with South Africa's fiscal policy objectives of inter-generational equity and debt-sustainability.

3.2 Empirical literature

This subsection of the literature review provides a survey of South African and international studies that have utilised the theoretical approaches discussed in subsection 3.1 and the results that have been found in these studies.

3.2.1 Contemporary literature on debt sustainability

The studies in this subsection show two approaches in the application of the debt sustainability theoretical framework. The first set of studies test sustainability by measuring whether policy-makers adhere to the inter-temporal budget constraint by increasing the primary balance when there is an increase in the debt-to-GDP ratio. The second set of studies is also in the vein of the debt-sustainability framework but centres on the related concept of solvency. In this second group of studies, the aim is to determine specific threshold levels of

debt-to-GDP beyond which a country's debt would be considered unsustainable. Unsustainability is defined as difficulty in servicing debt and interest obligations.

The studies cited in this subsection draw from actual country experiences in the United States of America, Brazil, Pakistan and South Africa.

Two approaches emerge from the literature concerning the *inter-temporal budget constraint* approach to fiscal sustainability. The first involves the estimation of the fiscal reaction function. The mechanics of fiscal reaction functions are discussed in detail in the methods section of this investigation. The fiscal reaction function is estimated using Ordinary Least Squares (OLS) techniques. In the estimated model, the debt-to-GDP ratio is the dependent variable, and the primary balance is the independent variable. Bohn (1998) used this approach to show that fiscal policies of the federal government of the United States of America (US) from 1916 to 1995 were debt sustainable because the primary surplus had a positive relationship with the level of debt. That is, there was an increase in the primary balance in response to an increase in the debt stock. This is the fiscal reaction. As such, the debt is sustainable because over the long run, the government respected its inter-temporal budget constraint by acting to stem debt accumulation.

The model proposed by Bohn (1998) utilised the debt stock and temporary spending measures as explanatory variables for the change in the US primary balance. Later studies have built on this approach and added more explanatory variables. For instance, Mahmood and Malik (2007) estimated a fiscal reaction function for Pakistan and argued that between 1965 and 2006, the fiscal reaction differed in periods of a recession and an economic boom. The reaction was insignificant during recessions. As such, they add the output gap as an explanatory variable in the model they estimate. De Mello (2008) estimated a fiscal reaction function for Brazil and found that the government will choose to phase in a fiscal adjustment instead of reducing the deficit in one period to a level consistent with the government's inter-temporal budget constraint. As such, De Mello (2008) included lagged values of the primary deficit as an explanatory variable. The latter two studies also advance thinking on estimation techniques while confirming the correctness of the OLS techniques. The authors use the vector-autoregressive (VAR) approach, which estimates the fiscal reaction function coefficients of debt, the deficit, and the output gap by taking into account that they are time series. Burger et al. (2012) estimate a fiscal reaction function for South Africa between 1946

and 2008. The authors include as their explanatory variables the lagged primary balance, debt-to-GDP and the output gap. The authors find that South African debt throughout this period has been sustainable.

The next broad class of inter-temporal budget constraint tests looks for a cointegrating relationship between tax revenues and government expenditures or the primary balance and the debt-to-GDP ratio. This class of studies builds on the investigation by Trehan and Walsh (1991), who find that if the debt and primary balance time series are integrated of the same order and a cointegration relationship can be found, then the inter-temporal budget constraint is satisfied, and the debt is sustainable. This condition is confirmed by Quintos (1995) and Bohn (2007). A study of the South African public finances by Biggs (1996) uses this approach to test sustainability. The author fails to find a cointegrating relationship between the fiscal variables and therefore rejects sustainability. As such the government violates the inter-temporal budget constraint. The results of this study are contradicted by South Africa's actual fiscal outcomes since the debt-to-GDP ratio declined from 49.5% in 1995/95 to 26% in 2008/09 (National Treasury, 2018). This result highlights a drawback of testing only for a cointegrating relationship between variables. The cointegration test is a retrospective test, which means it can only tell a researcher whether fiscal policies in the past resulted in a debt sustainable outcome. It cannot be used to test the sustainability of prospective fiscal policy.

Studies on *debt dynamics* focus on future fiscal policy by forecasting debt accumulation that results from present-day taxation and spending decisions. Ncube and Brixiovia (2015) use such an approach to argue, for instance, that high rates of economic growth and falling interest rates meant that the inter-temporal budget constraint condition was satisfied for several African countries even as they ran small primary deficits in the period 2000 to 2008. In the case of South Africa, for example, the authors find that after taking into account inflation, the real interest rate that South Africa was paying for its public sector borrowing was closer to 1%, while real economic growth was on average 4.2%. What this meant is that the debt stock was growing at a slower pace than tax revenues, which in turn supports debt sustainability.

An interesting application of the debt-dynamics framework has been the emergence of literature following the 2008 financial crisis that aims to determine thresholds beyond which

the public debt is unsustainable. The most famous and controversial⁷ application of this approach appears in the studies by Reinhart and Rogoff (2010; 2011) which argue that once public debt exceeds 90%, then there is a reduction in economic growth and a stronger likelihood that the government will default on its debt obligations. The updated International Monetary Fund (2013) approach to public debt sustainability assessments builds on a similar framework of debt limits⁸ to argue that once an emerging market country exceeds a debt level above 75% of GDP, it has a higher probability of default. As such, the public debt is unsustainable if it is above this level. Two studies attempt to determine a sustainable public debt level threshold for South Africa. The first is Naraidoo and Raputsoane (2013), who use a time-series dataset of government debt from 1865 to 2010 to find that if the South African government maintains a debt-to-GDP ratio below 56%, then it should not have difficulty financing its debt obligations. The second study (Saxegaard, 2014) finds that South Africa would be at risk of default if public debt were to exceed 59% of GDP. From these last two studies it can be inferred that the South African national debt is sustainable if it is below a range of between 56 to 59% of GDP. If the public debt is between or above this range, it is likely that the government will find its debt to be unaffordable.

3.2.2 Literature extending debt sustainability to subsidisation of a public utility

Regarding the question in subsection 1.3 about whether *public finance subsidies can be provided to public utilities and a debt sustainable outcome for the government be achieved*, the academic literature suggests a negative relationship. Equally, the commentary of South Africa's public finance authorities suggests that the answer is that subsidies to state-owned companies (SOCs) would detract from the debt sustainability of government (National Treasury, 2018)

Williams and Ghanadan (2006) cite instances in several countries where subsidies for state-owned electric utilities accounted for up to a quarter of the persistent deficit and were contributors to an unsustainable debt and macroeconomic position. A later paper by Carranza et al. (2014) surveys six Latin American countries and makes a similar finding. The authors identify two channels which lead to an unsustainable position. The first channel is the direct channel, whereby subsidies for investment by public utilities lead to deficits, which in turn

⁷ See Herndon et al. (2014) for a rebuttal of the claims made in the paper.

⁸ These limits are not only limited to the debt level but also include assessments of the country's gross financing needs and debt profile which includes *market perception, external financing, the share of short-term debt, debt held by non-residents and foreign currency debt*. These limits are not discussed in this investigation.

drive debt accumulation. The next channel, according to the authors, is when large debt stocks drive up economy-wide interest rates and dampen overall gross fixed capital formation, which leads to lower long-term growth. Lower growth and higher interest rates result in an unsustainable debt burden.

3.2.3 Literature that covers the valuation of government guarantees

None of the literature cited above considers the impact of public finance support through guarantees on debt sustainability. In the case of Eskom, the greater proportion of public finance subsidisation has been in the form of government guarantees and not direct subsidies. The drawdowns on these guarantees amounted to R218 billion in the 2016/17 financial year (Eskom, 2017). The question to answer is whether this decision to provide a guarantee instead of a subsidy has resulted in a better debt sustainability position for the public finances.

However, before outlining the methodological approach that has been taken to evaluate the fiscal cost of government guarantees, it is important to motivate the exercise. Governments issue guarantees to improve the terms on which a firm borrows by reducing the firm's interest cost (Mody and Patro, 1996). As has already been noted in the theoretical discussion, guarantees also lead to the accumulation of hidden government deficits and liabilities (Ibid). This is because governments have an incentive to improve the primary deficit by providing guarantees instead of outright cash subsidies, which will worsen the deficit and raise public debt (if financed through borrowing) (Ibid). As such, it is recommended in the study by Hofmans and van de Coevering (2014) that governments adopt the approach of the Dutch government to the management of guarantees. According to the authors, the Dutch government treats the issuance of guarantees as a budgeting decision. What this means is that policymakers have to choose between a cash subsidy and a guarantee for a firm. Two criteria are considered: the riskiness of a firm and its ability to generate sufficient cash flow to service the debt being incurred. A firm where revenues are uncertain or a firm that is unlikely to generate sufficient cash flow is riskier and therefore less likely to receive a guarantee.

Even if guarantees are justified by the firm's financial position and performance, Lewis and MacKinnon (1987) argue that guarantees encourage firms to borrow more than they would had a guarantee not been extended. If a firm over-extends itself to the point where it cannot

service its debt and interest obligations, the government has to step-in and settle the obligations falling due on the firm's behalf. In such an instance, the authors contend, a series of cash subsidies is a better option because it spreads the cost of public finance support over a period instead of requiring a single large payment to make good on the guarantee.

Having established a rationale for the valuation of guarantees, consideration is given to how guarantee valuation has been practically applied in the academic literature. Baldwin et al. (1983) provide the earliest example of a study that implements the approach proposed by Merton (1977) of applying the Black and Scholes (1973) options pricing framework. Baldwin et al. (1983) define risk as the standard deviation of the annual returns of the firm. The value of a US\$200 million loan guarantee can differ depending on the riskiness of the firm. In the study, the authors present two cases: a high-risk firm and a low risk firm both of which receive a US\$200 million guarantee. In the case of the high-risk firm the guarantee is equivalent to a recapitalisation of US\$166 million. In the case of the low-risk firm, the recapitalisation would be US\$10 million. This means that if the risk of the firm is reduced, the cash grant equivalent of the guarantee falls from \$166 million to \$10 million. In a case where there is high variability in a firm's returns, the risk is relatively elevated. In this case, the equivalent fiscal support required to match a guarantee would be very high. This underscores the point made by Hofmans and van de Coevering (2014) that as the risk of a firm increases (and hence the likelihood of default), so does the value of a guarantee. This means that at very high levels of risk, the guarantee equals the subsidy required from the shareholder.

The preceding discussion raises an important methodological question: how does one determine the inputs into the options pricing model? This is particularly relevant for a state-owned company that is unlisted and does not have actively traded equity securities. The solution is to base the estimate on the movement of the values of the underlying security being guaranteed. Cheah and Liu (2006) use options pricing to value a minimum revenue guarantee for a bridge built between Malaysia and Singapore. Since the minimum revenue of the bridge is a function of traffic volumes, the risk parameter is the standard deviation of traffic volumes on the bridge. Brandao and Saraiva (2008) use the same approach for a bridge project in Brazil's Amazon forest.

Given the objectives of this investigation, the investigation done by M'pasi (1995) is highly instructive. This study focuses on the year 1995. This study is useful for two reasons. First, the

underlying security being valued is a loan guarantee to Eskom. Second, the author provides insights into how to estimate the parameters of the risk of the guarantee. Specifically, he uses the standard deviation of the daily price movements of Eskom's listed securities. In this study, the author finds that an R112 million loan guarantee would be equivalent to a direct fiscal subsidy of R28-million from the public finances.

From this discussion it can be argued that there is a shadow cost of a government guarantee on the debt sustainability of the public finances. This shadow cost can be estimated using the debt sustainability and the guarantee valuation frameworks.

3.2.4 Contemporary literature on valuation of public investment

So far, this literature review has only considered the impact of guarantees and subsidies on debt sustainability. However, other studies show that in certain instances, public finance subsidies improved the financial position of power utilities. Consider the study by Stadelmann and Frisari (2015), where they show that a subsidy provided by the Moroccan government for a project to generate electricity reduced the investment cost of the project by 13%. The authors show that the funding lowered the interest rate on the project as lenders viewed the project as less risky because the government underwrote it. Sasaki and Nakayama (2016) show that for an electricity investment project between England and Iceland, funds from the public finances would raise the value of the project and make it profitable.

3.3 Research gaps filled by this study

Two research gaps emerged from this review. The first is that while studies have tracked the evolution of public finance systems and the sustainability thereof, no study has isolated and examined the cost to the public finances of indirect support through guarantees to the state-owned company sector. Equally, no study has evaluated whether public finance support improves the financial performance (measured by discounted cash flow) of state-owned companies. This study aimed to close this gap by investigating the case of the support provided to Eskom.

A significant proportion of the South African government's support to Eskom has been through government guarantees. The official public finance reviews published by the National Treasury and the South African Reserve Bank acknowledge that guarantees have an impact on the sustainability of the public finances (National Treasury, 2018; South African Reserve Bank, 2018). However, there is still relatively little research around the relative merits of

direct subsidies compared to guarantees. This is a second gap, which this study aimed to close. The results of this study will contribute to the literature on guarantee valuation, which has excluded considerations of debt sustainability.

Optimal firm capital structure, beginning with the work of Modigliani and Miller (1958), is an area of the literature that is well researched. For instance, there are several studies about firm capital structure in Africa. However, there is little research relating this theme to SOCs aside from Chinese studies such as those by Chen (2005) and Huang and Song (2006). This omission is possibly unjustified given how dominant SOCs are in the sectors in which they operate. For example, as noted, Eskom supplies 90% of South Africa's electricity, and the utility accounts for approximately 60% of all installed generation capacity in Sub-Saharan Africa (KPMG, 2014). This present study contributes to the literature by testing if the Modigliani and Miller (1958) hypothesis holds in the case of a state-owned company.

Additionally, there is no study that links the valuation of a guarantee to the valuation of a firm and to the sustainability of the public finances. This omission is particularly glaring in the case of South Africa that has used guarantees extensively to assist state-owned companies to obtain funding to build infrastructure.

This study adds to the existing literature on the valuation of guarantees but adds two further factors that have not been considered in previous studies, namely: (i) the impact of a guarantee on the public finances, and (ii) the impact on the valuation of a firm. Essentially, what is the cash-flow impact of a guarantee? This study was an attempt to build a tool to assist policymakers to consider the trade-offs involved in funding using a guarantee or funding directly from the public finances.

The issue of low profitability is not unique to Eskom; it is a phenomenon affecting electricity utilities globally (McKinsey & Company, 2018). Returns are low, for much the same reasons as they are low at Eskom. These reasons include falling electricity demand, which is shown in Figure 3 (Ibid). Cost overruns in the construction of new projects are also a common problem within the sector (McKinsey & Company, 2015). Also, the transition of energy production from fossil fuels to renewable sources means that firms and households increasingly generate their own electricity and are not as reliant on utilities as in the past (McKinsey & Company, 2018).

The contribution of this study is that it examined the role that funding approach plays in exacerbating the challenge of low return.

4. Hypotheses

Based on the research questions for this study, the hypotheses are:

1. The subsidies that the South African government provided to Eskom in the period 2006/07 and 2016/17 did not result in an unsustainable debt path.
2. The public finance subsidies provided to Eskom were justified because they resulted in a positive firm valuation for the utility and an economic profit.
3. Greater public finance subsidies, in the place of a guarantee, could have been provided to the utility between the years 2006/07 to 2016/17 without violating the objective of debt-sustainability.
4. Greater public finance support would result in a positive firm valuation and economic profit for Eskom.

5. Research methodology and data

This section builds upon the literature review and outlines the research methods used to validate or invalidate the hypotheses in section 4. This section has four major subsections. The first part describes the data used in the study. The second discusses the ethical considerations of this report. The third is an introduction of the scenario-based approach that was used to test the hypotheses. The fourth part of this section consists of a series of descriptions of the methods that were used to test the sustainability of debt in each of the scenarios and the valuation and economic profit of Eskom under the *baseline* and two alternative scenarios.

5.1 Data requirements for the study

The data used to test the hypotheses runs from 1980 and 2017. However, the focus of this study covered the period 2006/07 to 2016/17, which is the period from the inception of Eskom's new build programme up to the most recent audited annual financial statements of both the national government and the utility. The units of analysis for this study are Eskom and the South African government, specifically examining the time series of debt and the primary balance in the case of the South African public finances and annual cash flows in the case of Eskom.

Debt-sustainability was estimated using a fiscal reaction function and confirmed by the cointegration test. This approach required annual public finance data sourced from the *South African Reserve Bank Quarterly Bulletin* database. Performing the firm valuation analysis for Eskom required the building of a discounted cash flow model for the utility. The inputs for the discounted cash flow model were sourced from Eskom's annual financial statements and regulatory filings such as tariff applications to the NERSA and Bloomberg. In Eskom's statement of financial position and supporting notes, the utility discloses additional information about its debt such as its value when it matures and the proportion of debt that has been guaranteed by the government. An assurance of the reliability of Eskom's annual financial statements is that they are prepared according to the International Financial Reporting Standards (IFRS) framework.

5.2 Ethical considerations

This study exclusively relies on publicly available secondary data such as published reports or data releases from official agencies such as the South African Reserve Bank; as such ethical limitations were minimal.

5.3 Scenarios

Testing each of the hypotheses required the development of "what-if" scenarios. Two alternative scenarios around a *baseline* scenario were developed in this study. The baseline scenario describes what actually happened to the public finances and Eskom in terms of the subsidy that the utility received from the public finances, debt accumulation, sustainability, and the utility's financial outcomes over the period 2006/07 to 2016/17.

To prove the first and second hypotheses, a first alternative scenario was constructed in which Eskom was not given any public finance subsidy. This scenario is called the *no-support* scenario. This scenario assumes Eskom did not have the R350 billion government guarantee facility and that government did not provide the utility with R91 billion in subsidies. An adjustment is then made to the debt-dynamics model (equation (3) below) to project how much lower the primary balance and the national debt stock would have been compared to the *baseline* scenario. The debt-sustainability of this hypothetical scenario was tested and compared to the *baseline* scenario. Next, the second hypothesis was tested by assessing if Eskom's valuation and economic profit (using equations 6, 7 and 8 below) became negative.

Disproving the third and fourth hypotheses required a scenario in which instead of a guarantee, Eskom received additional temporary annual public finance subsidies equivalent to the government's guarantee exposure. This would result in higher government spending. This scenario is called the *more-support* scenario. An adjustment was made to the debt-dynamics model to account for the higher spending due to the increased subsidies to Eskom. The projection being made was how much higher the primary balance and the national debt stock would have been compared to the *baseline* scenario. Next, the debt sustainability of the wider primary deficit and debt path were tested and compared to the *baseline* scenario. Finally, to prove the fourth hypothesis, valuation and economic profit modelling were performed to evaluate if these variables would have been positive if Eskom had received greater public finance subsidises.

5.4 The modelling for the investigation

In order to test the previously stated hypotheses, three models were developed. The first is a guarantee valuation model, the second a debt-sustainability model, and the third a discounted cash flow valuation model. The equations for each of these models are shown below.

Table 2 provides details of what each variable in the equation stands for, how it is sourced and how it is measured. Merton (1977) estimates the value of a government guarantee $G(T)$ as shown in equation (1). It was only applied to test the *more-support* scenario. Next, the debt path for each scenario was estimated using the debt-dynamics model proposed by the International Monetary Fund (2013). This model is shown as equations (2) and (3). Once the debt path had been determined, the fiscal reaction function proposed by Bohn (1998), shown as equation (4), could be estimated to test the hypotheses of debt sustainability. Next the hypotheses related to Eskom's financial performance could be tested using a discounted cash flow and economic profit valuation shown in equations 5, 6, 7 and 8.

$$G(T) = Be^{-rt}N\left(\frac{\left\{\log\left(\frac{B}{V}\right) - \left(r + \frac{\sigma^2}{2}\right)\right\}}{\sigma\sqrt{T}} + \sigma\sqrt{T}\right) - VN\left(\frac{\left\{\log\left(\frac{B}{V}\right) - \left(r + \frac{\sigma^2}{2}\right)\right\}}{\sigma\sqrt{T}}\right) \quad (1)$$

$$pb_t = Rev_t - baseline\ nie_t \pm subsidies_t \quad (2)$$

$$d_t = \left(\frac{e_t}{e_{t-1}}\right) * (1 + i_t^f) * d_{t-1}^f + (1 + i_t^d) * d_{t-1}^d - pb_t \quad (3)$$

$$pb_t = \alpha + \rho_1 \cdot d_{t-1} + \rho_2 \cdot pb_{t-1} + \rho_3 \cdot gap_{t-1} + \rho_4 \cdot temp_t + \varepsilon_t \quad (4)$$

$$Firm\ Value_t = \sum_{t=1}^{\infty} \frac{Free\ Cash\ Flow_t}{(1+WACC)^t} \quad (5)$$

$$Free\ Cash\ Flow_t = Net\ Profit\ or\ loss\ after\ tax_t - \Delta\ Invested\ Capital(IC)_t \quad (6)$$

$$\Delta IC_t = Debt_t + Shareholder's\ equity_t - Debt_{t-1} + Shareholder's\ equity_{t-1} \quad (7)$$

$$Economic\ Profit_t = Net\ Profit\ after\ tax_t - Invested\ Capital_t \times WACC_t \quad (8)$$

Table 2: Model arguments for this investigation

Variable	Meaning	Unit	Measurement	Frequency	Source
Merton (1977) Guarantee valuation model					
$G(T)$	Value of government guarantee	Rand billions	Nominal	Annual	Author's own calculation
V	Value of Eskom's assets	Rand billions	Nominal	Annual	Eskom annual financial statements; Bloomberg
B	Face value of guaranteed Eskom debt	Rand billions	Nominal	Annual	National Treasury 2017 Budget review
Be^{-rt}	Continuously discounted redemption value of guaranteed debt	Rand billions	Nominal	Annual	Author's own calculation
r	risk-free interest rate (Yield to maturity on R186 government bond)	Per cent	Nominal	Annual	Bloomberg
σ	Standard deviation of Eskom bond price	NA	NA	Annual	Bloomberg
$N(x_1)$	Cumulative normal distribution	NA	NA	Annual	Author's own calculation
IMF (2013) Debt dynamics formula					
pb_t	Primary balance	Per cent of GDP	Nominal	Annual	National Treasury 2017 Budget review
Rev_t	Total government revenue	Per cent of GDP	Nominal	Annual	National Treasury 2017 Budget review
$baseline_{nie}_t$	Non-interest spending by the national government	Per cent of GDP	Nominal	Annual	National Treasury 2017 Budget review
$subsidies_t$	Subsidy provided to Eskom in the year	Per cent of GDP	Nominal	Annual	Author's own calculations
d_t	Gross-loan debt as a percent of GDP	Per cent of GDP	Nominal	Annual	SARB Quarterly Bulletin
e_t	Nominal exchange rate	Rand per US dollar	Nominal; End of period	Annual	SARB Quarterly Bulletin
i_t^f	Interest rate on debt stock denominated in foreign currency	Per cent	Nominal	Annual	SARB Quarterly Bulletin
d_{t-1}^f	foreign debt as a percent of GDP	Per cent of GDP	Nominal	Annual	SARB Quarterly Bulletin
i_t^d	Interest rate on debt stock denominated in domestic currency	Per cent	Nominal	Annual	SARB Quarterly Bulletin
Bohn (1998) fiscal reaction function					
α	Regression intercept term	NA	NA	Annual	Stata VAR output
ρ_1	Coefficient term for the response of the primary balance to a change in the debt stock	NA	NA	Annual	Stata VAR output
ρ_2	Coefficient term for the response of the primary balance to a change in the lagged primary balance	NA	NA	Annual	Stata VAR output
ρ_3	Coefficient term for the response of the primary balance to a change in the output gap	NA	NA	Annual	Stata VAR output
ρ_4	Coefficient term for the response of the primary balance to a change in government spending on capital goods and services	NA	NA	Annual	Stata VAR output
gap_{t-1}	Output gap measured as the difference between potential output and actual output	Per cent of potential GDP	Nominal	Annual	Author's calculation using Hodrick and Prescott (1981) filter method and SARB Quarterly Bulletin data
cap_t	Government capital spending as a per cent of GDP	Per cent of nominal GDP	Nominal	Annual	SARB Quarterly Bulletin

5.4.1 Determining a fiscal equivalent value for government guarantees

In the literature review, several studies were cited where the options pricing method was used to determine the public finance cost of issuing a guarantee. Since a guarantee is a commitment to repay the lender in cash should the issuer of the guaranteed debt default, the options value of a guarantee is equivalent to a commitment for an equity contribution from the public finances if the debt issuer defaults (Baldwin et al. 1983).

From equation (1), it can be seen that the value of a guarantee depends on two factors: the continuously discounted face value⁹ of the guaranteed bond Be^{-rt} and V , the market value of the firm's assets. As the value of the firm's assets increases, the value of the guarantee decreases. This is because the assets of the firm would fetch enough cash in a sale to allow the firm to service its guaranteed debt. Similarly, if the value of the firm's guaranteed debt increases, it becomes more onerous for the firm to service the debt and increasingly likely that the firm will default on its obligations. In this case, the guarantee is more valuable to the bondholder because it is highly likely to be exercised. Each of these states described are probabilistic. In other words, until the debt matures, the holder of the guaranteed debt cannot know with certainty whether the firm will default or have assets sufficient to settle its obligations. The probability that the guarantee will be exercised is calculated using the standard normal distribution¹⁰ function: as the probability that the guarantee will be called increases, the value of the guarantee tends towards the face value of the guaranteed debt. However, if the probability that the guarantee will be called declines, then the value of the guarantee falls to zero. In this case, the guarantee is considered worthless because it will never be exercised, and the firm does not derive much value from the guarantee being in place.

Given this description, the values of x_1 and x_2 are the test statistics that were used to determine these respective probabilities, that is, the probability that the firm would be unable to settle the guaranteed debt obligation B measured by $N(x_2)$ and the probability that the firm will have sufficient assets to settle its debt obligations when they mature. The values of

⁹ Face value of debt is the amount that a borrower promises to repay the lender when the debt matures.

¹⁰ The continuous normal distribution is a measure of the probability of a variable being equal to or less than some pre-defined value. As a result, the value of a cumulative normal distribution lies between 0 and 1 because probability lies between 0 and 1.

$N(x_1)$ and $N(x_2)$ will lie between zero and one. As discussed in the literature review, the value of volatility depends on the movements of the value of the underlying security. The underlying security is Eskom's debt portfolio; therefore, volatility was calculated based on the daily price movements of the guaranteed debt securities. This is line with the approach proposed by M'pasi (1995).

5.4.2 Estimating the debt dynamics

The debt path for each scenario was estimated using the debt-dynamics model proposed by the International Monetary Fund (2013) and shown in equation 3. However, based on the scenario, a new primary balance path was estimated with equation 2. In the *more-support* scenario, the fiscal equivalent of the government guarantees, calculated using equation 1, was added to the primary balance as a subsidy, and this resulted in a greater primary deficit.

5.4.3 Debt-sustainability analysis by estimating a fiscal reaction function

Estimating equation (4) was the central analysis for proving debt sustainability. It is worth recounting how this equation proves sustainability. It begins with recognising that the government's one-period budget constraint defined by Bohn (1998) is:

$$pb_t = \Delta d_t + \left(\frac{r-g}{(1+g)} \right) (d_{t-1}) \quad (9)$$

That is, if the government is adhering to its one-period budget constraint, then the primary surplus, as a share of GDP, will at least equal the change in the debt stock and the automatic change in the debt burden due to interest costs and economic growth. If this relation holds, then the sovereign debt burden is not increasing as a share of GDP. As discussed in the literature review, this one-period constraint is generalised to the inter-temporal budget constraint, which requires the present value of future primary surpluses to be equal to the value of the debt stock:

$$d_{t-1} = \sum_{t=0}^{\infty} \frac{pb_t}{(1+r)^t} \quad (10)$$

Bohn (1998) proves that adherence to this constraint can be measured by measuring the fiscal reaction function (FRF). The FRF is an attempt to determine a relationship between the primary balance and the debt stock in order to determine sustainability.

From the estimated fiscal reaction function, sustainability is assured if the coefficient for public debt is positive and significant (Bohn, 1998; Bohn, 2007). In the fiscal reaction function

(equation 4), the lagged primary balance pb_{t-1} was included to account for the fact that the response of the fiscal authorities might be lagged or that the fiscal adjustment might be done over time instead of in one period (Ibid). This approach was similar to that taken by Mahmood and Malik (2007) and De Mello (2008). The output gap is also included as an explanatory variable because the deficit might be driven by a desire for a counter-cyclical fiscal policy. The output gap was estimated using Hodrick and Prescott's (1997) filter approach. Temporary spending is included as an explanatory variable, and the data for this was sourced from the document *The Adjusted Estimates of National Expenditure*, under the title *Unforeseen and Unavoidable* spending. This document is published by the National Treasury as part of South Africa's appropriations process. The fiscal reaction is estimated with exogenous variables for the output gap and temporary spending in the following form:

$$\begin{bmatrix} pb_t \\ d_t \\ gap_t \\ temp_t \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} & A_{13} & A_{14} \\ A_{21} & A_{22} & A_{23} & A_{24} \\ 0 & 0 & A_{33} & 0 \\ 0 & 0 & 0 & A_{44} \end{bmatrix} \begin{bmatrix} pb_{t-1} \\ d_{t-1} \\ gap_{t-1} \\ temp_{t-1} \end{bmatrix} \quad (11)$$

5.4.4 Implementing the fiscal reaction function

The fiscal reaction function was implemented using a vector autoregression (VAR). This model was first developed to study macroeconomic phenomena (Sims, 1980). A VAR model is one in which the dependent variable is explained by its own lag value (Ibid). In this case, as it is shown in equation (3), the movement of the primary balance is explained by its own lagged value because policymakers react only gradually to changes in the debt stock. Specifying the model to be estimated as a vector is appropriate because the primary balance is a reaction to positive debt accumulation. The change in the debt stock is also determined by the change in the primary balance as shown in equation 4; there is simultaneity between the debt stock and the primary balance.

In implementing the FRF model, two pre-estimation tests were performed, namely stationarity tests on the debt and primary balance time series, and optimal lag length tests. The Augmented Dickey-Fuller (ADF) test was used to test stationarity, and the Phillips-Perron unit root test was used to confirm the result. The appropriate lag length for the model was determined using the Akaike Information Criteria (AIC) and Schwarz Information Criteria (SIC). The *a priori* expectations based on the literature are that the appropriate lag length is 1. After the fiscal reaction function was estimated, three post-estimation tests were performed to

ensure the quality of the results. The first is the Lagrange-Multiplier test, which was done to ensure that the model residuals are not autocorrelated. The second is the Jarque-Bera test, applied to ensure that the model residuals are normally distributed. Finally, the Eigenvalue-stability test is used to confirm that the estimated VAR model is stable and a mean reverting process. This was to ensure that the variances and covariances are time invariant. This means that the estimated coefficients of the fiscal reaction function are stable and will not change over time.

If the above tests indicate that the estimated fiscal reaction function is well specified, then the impulse response functions (IRFs) can be estimated and interpreted. IRFs are necessary in order to interpret the coefficients of VAR regressions, which cannot be interpreted directly from the regression output (Tsay, 2010). The IRFs are generated based on the fiscal reaction function that has been estimated. The interpretation of the IRF is the change of the independent variable due to a shock to the regressor.

5.4.5 Cointegration relationship and Vector Error Correction Model

It has been discussed in the literature review that long-run debt sustainability can also be established by showing that debt and the primary balance are integrated of the same order and that variables are long-run cointegrating (Trehan and Walsh, 1991; Quintos, 1995; Bohn, 2007). The integrating order of the time-series can be found with the ADF test. After establishing that the variables are integrated of the same order, the formal test for cointegration can be performed (the Johansen tests for cointegration). Cointegration is sufficient to prove sustainability. However, the long-run relationship between debt and the primary balance can be estimated with a vector-error correction model (VECM). This is in line with the cointegration method proposed by Trehan and Walsh (1991) and Quintos (1995) to determine the long-run adjustment of the primary balance. The concept of cointegration matters because it is used to determine whether there is a long-run relationship between the primary balance and the debt stock. The VECM is then estimated to quantify this long-run relationship. It can be interpreted directly without needing to generate impulse responses. The quality of the coefficients is verified using same post-estimation tests for the VAR fiscal reaction function, namely: the Lagrange-multiplier test for autocorrelation, the Jarque-Bera test for residual normality tests, and the Eigenvalue-test for model stability. This can be done because underlying the vector error correction model is a vector autoregression.

5.4.6 Eskom valuation and economic profit analysis

To test the second and fourth hypotheses, a valuation analysis was conducted using the Discounted Cash Flow (DCF) methodology. The approach builds on the study by Modigliani and Miller (1958) described in the theoretical framework. The key conclusion of the study is that firm value is determined by the equity that a firm creates through its investment decisions.

There are three steps to measuring the value of the firm. In line with the Modigliani and Miller (1958), the first is to determine the equity generated for shareholders by the firm. This was done using an accounting measure called *Free Cash Flow*. This is the cash that is left over after a firm pays its operational and capital expenditures and is rightly considered the equity or firm value due to shareholders (Koller et al. 2010). The second step was to discount this free cash flow by Eskom's WACC, which is reported in its regulatory submissions to NERSA for tariff adjustments. The third step was to determine the economic profit earned by Eskom under the different scenarios, which is the normal profit less the firm's opportunity cost measured as the capital charge.

From Modigliani and Miller (1963), it is understood that because of market imperfections and taxes, the relative weighting of debt and equity do influence the firm's value. As such, adjustments were made to take this into account. In the *baseline scenario*, no adjustments are made to Eskom's free cash flow reported in its annual financial statements or to the WACC reported in its regulatory filings. Only in the alternative scenario were adjustments made, which are in line with the results of Modigliani and Miller (1963). They are as follows:

1. **Profit and free cash flow:** Changes to Eskom's debt burden would change Eskom's profitability and free cash flow. This is because Eskom would have lower debt-service costs since it accumulates less debt because it has more capital contributions from the public finances. This improvement in profitability is slightly offset by the higher tax expense the utility would incur because of the reduction in debt service payments.
2. **Debt accumulation and capital structure:** Recall from section 1 that Eskom meets its debt-service payments by borrowing to pay them. As such, as Eskom's debt service payments and borrowing (and hence debt burden) will change.

3. **Weighted Average Cost of Capital (WACC):** As discussed in Section 4, the utility's WACC will adjust due to the change in the weight of debt and equity. The cost of debt and equity was unchanged in all scenarios.

After taking into account these three adjustments, the utility's economic profit was determined for each scenario using the approach proposed by Koller et al. (2010), as shown in equation 8.

6. Results

In section 1.3 of the introduction, four objectives for this study were laid out. Two of these objectives were to establish whether the current level of subsidies to Eskom — and even more subsidies — would result in an unsustainable debt path. The second set of research objectives aimed to establish whether the same public finance subsidies have improved Eskom's cash flow and economic profit over the past decade and whether even more subsidies would have resulted in further improvements to valuation and economic profit.

This section is organised into five subsections. The first two subsections are a presentation of the inputs into the fiscal reaction function and Eskom financial model. The last three subsections are a presentation of the results of:

- i) debt sustainability analysis using the fiscal reaction function and cointegration approach and;
- ii) the Eskom valuation analysis using the discounted cash flow and economic profit approaches.

This section also includes a discussion of the results.

Table 3 sets out the R91 billion public finance support that was given to Eskom and the annual borrowing against the government guarantee by the utility, which cumulatively amounted to R218 billion in 2016/17. This represents the support provided to the utility by the national government.

Table 3: Public finance support provided to Eskom, 2006/07-2016/17

R million	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	Total
Guarantee utilisation ¹	-	-	-	46 578.0	20 379.0	10 173.0	26 293.0	21 602.0	24 819.0	24 642.0	43 414.0	217 900.0
Public finance support	-	-	-	10 000.0	20 000.0	30 000.0	4 000.0	4 000.0	-	23 000.0	-	91 000.0

1. This figure only accounts for the drawdown on the government support facility issued in 2009/10 and does not include any prior government guarantees to Eskom

Source: National Treasury

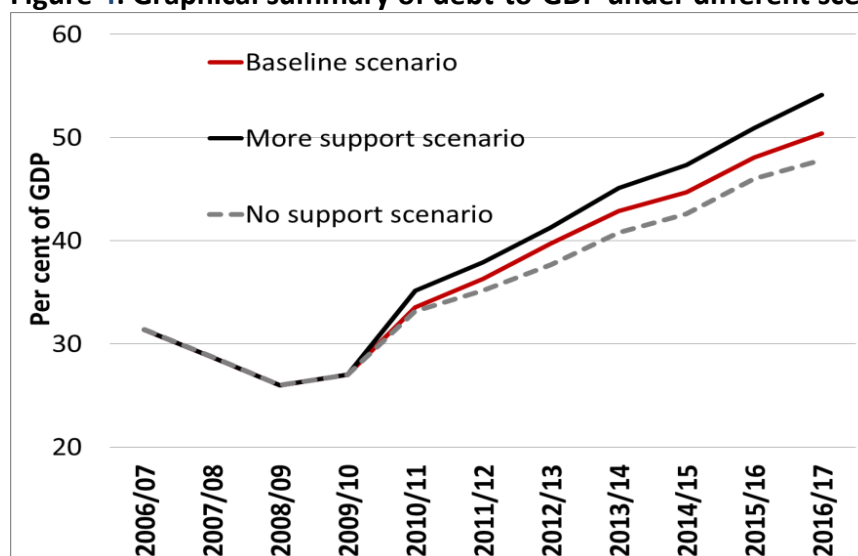
6.1 Guarantee debt to equity conversion based on the Merton (1977) model

Using the Merton (1977) model for guarantee valuation, it was found that the cumulative value of guarantee drawdowns of R218 billion over the period 2006/07 to 2016/17 would have been equivalent to additional fiscal support of R148 billion. This is the additional support that is used to derive the *more-support* scenario. This figure is an additional subsidy to the R91 billion subsidy that was provided to Eskom over the period. This means that in the *more-support* scenario the total fiscal support to Eskom would have been R239 billion, which is slightly more than Eskom's guarantee drawdown over the period. The details of this calculation are presented in annexure A of this report.

6.2 Results of the debt-dynamics model

Using the debt dynamics model, the debt and primary balance path for each scenario have been determined and are shown in figure 4 below. In the *baseline* scenario, the debt-to-GDP ratio is 50% in the 2016/17 financial year. In the *no-support* scenario government spending is lower by R91 billion, and so the debt-to-GDP ratio is 48% in the 2016/17 financial year. In the *more-support* scenario, government spending over the period is higher by the R148 billion, and so the debt-to-GDP ratio in 2016/17 is 54%. From the results of the debt-dynamics models, it can already be concluded that the debt path in each of the scenarios is sustainable because they are below the 75% prudential threshold proposed by the International Monetary Fund (2013). The calculated values are also below South Africa's specific range of 56 to 59% proposed by Naraidoo and Raputsoane (2013) and Saxegaard (2014) respectively. The results of the debt-dynamics suggest that the first and third hypotheses, which relate to the sustainability of the public finances could be accepted. However, formal estimation of sustainability was performed using a fiscal reaction function (FRF) to confirm the validity of the hypotheses. This is discussed next.

Figure 4: Graphical summary of debt-to-GDP under different scenarios



Source: Author's own calculations using data from the National Treasury

6.3 Fiscal reaction function results for sustainability

In all three scenarios, the ADF tests for unit roots show that the debt and primary balance series are non-stationary in level forms, but are first difference stationary. These test results are reported in Appendix B of this report. This means that in level form both series have unit roots. The Phillips-Perron test confirms these results. This means that all variables are integrated of order 1. The results of the lag selection criteria confirm that the optimal lag for each reaction function is 1, as is the case with the previous studies using an FRF discussed in the literature review.

The fiscal reaction functions for all three scenarios are presented in Table 4. The most important result is that in all three scenarios the coefficient on lagged debt-to-GDP is both positive and significant. Put differently fiscal authorities run smaller deficits or larger surpluses as the debt-to-GDP ratio increases. This means that the public debt is sustainable in all three scenarios.

Table 4: Estimated fiscal reactions functions for each scenario*

Variable name	<i>Baseline</i>	<i>No-support</i>	<i>More-support</i>
Primary balance (1 lag)	0.64 [0.00]	0.61 [0.00]	0.65 [0.00]
Debt-to-GDP (1 lag)	0.19 [0.00]	0.21 [0.00]	0.17 [0.01]
Output gap (1 lag)	-0.23 [0.54]	-0.19 [0.591]	-0.25 [0.542]
Temporary expenditure	-0.03 [0.00]	-0.04 [0.00]	-0.03 [0.01]
R-squared value	0.81	0.82	0.77

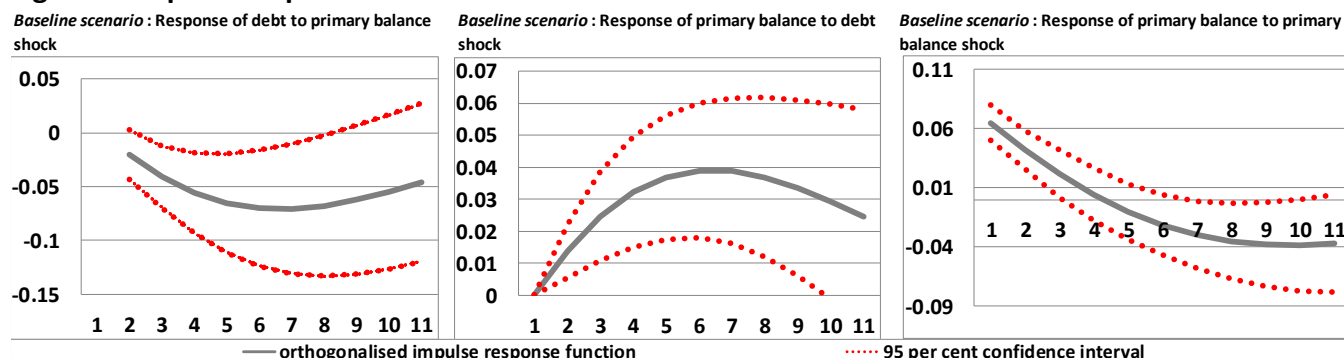
Source: author's calculations using data sourced from the SARB Quarterly bulletin

Values in parentheses are p-values

* The VAR estimation of the fiscal reaction function is performed on fiscal data from the period 1980 to 2016 or 36 data points

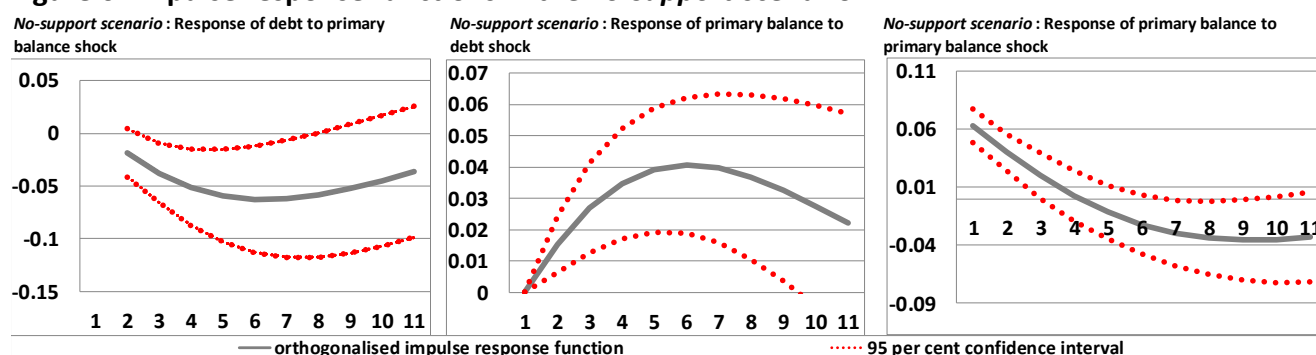
The post-estimation tests are also reported in Appendix B. These show that the estimated fiscal reaction functions in all scenarios are well specified in that they produce normally distributed error terms, do not exhibit autocorrelation, and have stable coefficients. Given the positive results of the post-estimation tests, the impulse response functions (IRF) for all three scenarios are generated in order to interpret the estimated fiscal reaction functions and are shown in Figures 5, 6 and 7.

Figure 5: Impulse response functions in the *baseline* scenario



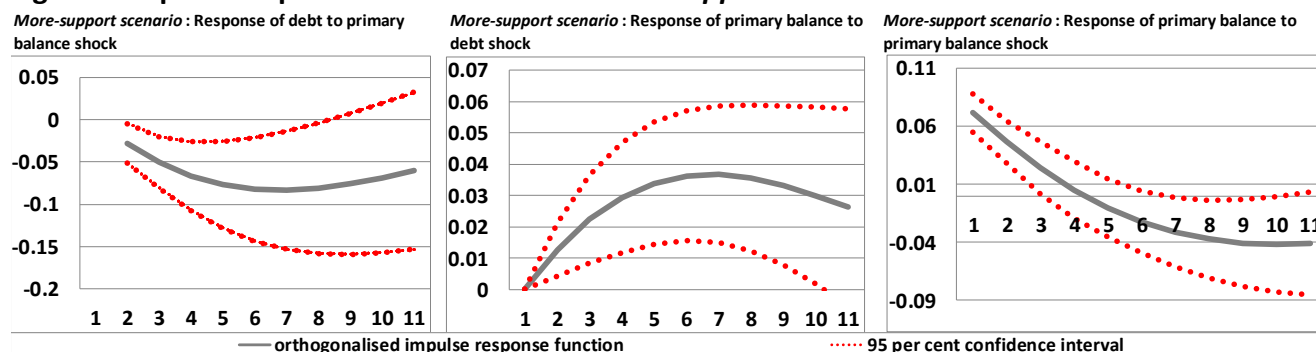
Source: Author's own calculations using data from the National Treasury

Figure 6: Impulse response functions in the *no-support* scenario



Source: Author's own calculations using data from the National Treasury

Figure 7: Impulse response functions for the *more-support* scenario



Source: Author's own calculations using data from the National Treasury

The key result is captured by the charts in the centre for all scenarios. The interpretations of the IRF are as follows. In the baseline scenario, a 1 standard deviation upward shock to debt-to-GDP ratio resulted in a 3.8% primary balance adjustment which began to die out after 6 periods. In the *no-support* scenario, sustainability was stronger in that the adjustment was 4.06% and died out after 7 periods. Finally, in the *more-support* scenario, the relationship was the weakest. The adjustment primary balance adjustment was 3.6% and as with the baseline it scenario died out after 6 periods.

6.4 Cointegration using a VECM

In all three scenarios the results of the Johansen test for cointegration yielded at least one cointegrating equation. This indicates a long-run relationship between the primary balance and the debt-to-GDP ratio. This is already an indicator that the estimated debt trajectories in all three scenarios are sustainable. Further, because there is a cointegrating relationship, the vector-error-correction model (VECM) was estimated to find the long-run relationship between debt and the primary balance. The results of the VECM estimation are summarised in the table below.

Table 5: Summary of VECM results for each scenario*

Scenario	<i>Baseline</i>	<i>No-support</i>	<i>More-support</i>
Debt coefficient	0.035	0.020	0.111
Constant	-0.006	-0.004	-0.007
Error correction term	0.417	0.467	0.355
Gross debt-to-GDP ratio in 2016/17 under scenario	50	48	54
Long-run adjustment (% of GDP)	1.22	0.51	5.28

Source: author's calculations using SARB QB data

* *The VAR estimation of the fiscal reaction function is performed on fiscal data from the period 1980 to 2016 or 36 data points*

The interpretation of the results is relatively straightforward. The first line in the table, the debt coefficient, indicates the long-run adjustment of the primary balance as a result of a 1% change in the debt-to-GDP ratio. The third line (*the error correction term*) indicates the proportion of the adjustment that takes place within one period. Assuming that support to Eskom had ended in 2016/17, the long-run surplus would have been achieved in 2019/20 in all three scenarios. As expected, the *more-support* scenario would have resulted in a larger adjustment than the other two scenarios because more public debt would have been accumulated in this scenario. The difference between the long-run primary balance adjustment in the *baseline* scenario and the *less-support* scenario is 0.71 percentage points. This suggests that the impact of the R91 billion support to Eskom on the public finances has been minor. Put differently, the support has resulted in a 4% higher debt-to-GDP ratio, but the required annual primary surplus to compensate for the support is only 1.5% higher than what it would have been had no subsidy been provided. The *more-support* scenario would require a 4% larger readjustment to the *baseline* because of the higher debt-to-GDP ratio. What this scenario shows is that while there is a relative weakening of the long-run

relationship between debt and the primary balance compared to the *baseline* scenario, the relationship does not break down, nor would the pace of deficit reduction noticeably slow down. This result is because the proposed support to Eskom would not have been so large as to offset the efforts by fiscal policy to reduce the primary deficit, particularly in the period following the 2008 Global Financial Crisis.

The post-estimation tests are reported in Appendix B. These show that the estimated VECM produces residuals are normally distributed and are serially uncorrelated in all scenarios.

The results of the *more-support* scenario show that the hypothesis “greater public finance subsidies, in the place of a guarantee, could have been provided to the utility between the years 2006/07 to 2016/17 without violating the objective of debt-sustainability” can be accepted. The public finances would have remained sustainable despite the additional spending to subsidise Eskom.

A reason for the consistent results of the debt dynamics in subsection 6.2, fiscal reaction function in subsection 6.3, and now the cointegration test is the structural changes to the primary balance over the decade. This can be seen by looking at the relative change of the primary balance in the *baseline* scenario and the *more-support* scenario. In the *baseline* scenario, the primary balance narrows in the period 2006/07 and 2008/09, and the debt-to-GDP ratio falls correspondingly. In 2009/10, the primary balance goes into deficit due to the economic contraction after the Global Financial Crisis between 2008 and 2009. From 2012 onwards, the primary balance narrows due to the following public finance measures to reduce borrowing:

1. The introduction of a non-interest expenditure ceiling in Budget 2012 to dramatically slow the growth of expenditure (National Treasury, 2012)
2. R25 billion reductions to allocations for government consumption in 2015, and increases of personal income tax rates in 2016 (National Treasury, 2015)
3. Increases in the fuel levy and the dividends withholding tax to raise an additional R35 billion in revenue (National Treasury, 2017)

The *more-support* scenario produces a sustainable outcome because the overall fiscal stance¹¹ remains contractionary as it is in the *baseline* scenario. In the *baseline* scenario, the primary balance narrows from -4.5% in 2009/10 to -0.5% in 2016/17. This is equivalent to a median positive fiscal impulse of -0.28, which indicates a fiscal contraction over the period. In the *more-support* scenario, the primary balance would narrow from a hypothetical 6.2% to 1% in 2016/17. Again, this reflects a fiscal contraction because the median fiscal impulse is -0.22. Again, this reflects a contractionary fiscal stance despite providing additional subsidies to Eskom. Of course, the fiscal adjustment would be slower in the *more-support* scenario. What this means is that replacing the Eskom guarantee with direct public finance support would not have contradicted the South African government's fiscal policy objective of consolidating the public finances and eliminating the primary deficit. It does mean that the pace of the consolidation would have been slower compared to the *baseline* scenario.

6.5 Results of the financial modelling

The second and fourth hypotheses relating to firm valuation and economic profit are rejected. In all three cashflow scenarios tested, Eskom has negative discounted cashflow or value and makes an economic loss. A summary of the results of the cashflow modelling is displayed in Table 6 below.

In all three scenarios, irrespective of the subsidies the utility receives, Eskom was value-destructive. In the *baseline* scenario, Eskom has a negative valuation (cumulative discounted cashflow in Table 6) of R155 billion, which would have risen to R181 billion if Eskom had not been given direct fiscal support. If Eskom had received additional subsidies, its valuation would have remained negative although it would have improved relative to the *baseline* scenario to R123 billion. This means public finance subsidies to the utility were not justified because of the negative financial metrics of the utility seen in table 6. However, public finance subsidies would help to slow the pace of value destruction by the utility.

¹¹ The fiscal stance is defined as the change in the structural primary balance or the primary balance adjusted for the business cycle. A negative value means tightening of fiscal policy, while a positive value indicates loosening of fiscal policy. This is not the same concept as expansionary or contractionary fiscal policy to manage aggregate demand in the economy.

Table 6: Discounted cashflow analysis results for each scenario, 2006/07-2016/17

R million	<i>Baseline</i>	<i>No-support</i>	<i>More-support</i>
Cumulative net-operating profit	60 875.0	29 368.1	100 027.9
Cumulative cashflow	-291 992.0	-348 004.3	-222 386.9
Cumulative discounted cashflows	-154 714.0	-181 028.6	-122 530.5
Cumulative capital charge	285 605.1	289 029.2	281 201.2
Cumulative economic profit	-224 730.1	-259 661.1	-181 173.3

Source: author's calculations using Bloomberg, SARB and Eskom data

The valuation results of the scenarios largely reflect the differences in the net-operating profit Eskom would have generated over the period. The decrease in debt in the *more-support* scenario would have reduced the utility's debt-service costs. This effect would have been partially offset by the loss of the tax shield which interest provides¹² and so the utility spends slightly more on tax. The utility's net operating profit would have been higher cumulatively by R39.1 billion compared to the baseline scenario. For the *no-support* scenario, the utility's net-operating profit would have been lower by R31.5 billion compared to the baseline scenario. The increased reliance on debt would result in higher debt service costs, which are partially offset by lower spending on taxes over the period.

The results of the economic profit modelling confirm the above valuation results. In all three scenarios, Eskom generates an economic loss and does not earn a sufficient return to compensate for the capital it uses to produce output. There are two reasons for the high economic loss: the first is that higher levels of debt raise the utility's debt-service costs. This directly lowers the utility's profit and the cash it generates. The second reason is that Eskom has to take on even more debt to service its interest payments since, as discussed in the introduction, the utility is not generating sufficient returns to service these with retained profits. These two factors raise the overall capital requirement and result in a higher capital charge. Likewise, since the utility has less debt in the *more-support* scenario, it has lower economic losses. The conclusion, therefore, is that while government subsidies could not be justified because there is negative economic profit in the *baseline* scenario, there is justification in that the government subsidies helped to limit the extent of the economic loss incurred by the utility. These economic losses would have been higher if Eskom had to take on more debt. This can be seen by comparing the lower result of economic profit in the *no-*

¹² A company's interest expense is a deductible expense for tax purposes

support scenario (R-259.7 billion) to the higher value in the *baseline* scenario (R-224.7 billion). Details of these calculations can be found in annexure C of this report.

The reasons for these negative results can be placed into two broad categories: factors internal to Eskom and issues external to Eskom. Concerning the internal factors that explain the results, it is not surprising that Eskom has had negative cash flows and has incurred economic losses. In general, capital investment programmes of electricity utilities are costly and have long lead times before they are completed and start generating electricity and revenue (McKinsey & Company, 2015). In the case of Eskom, however, the extent of the cash losses is also explained by the cost overruns and construction delays on the investment programme (Styan, 2015). Eskom (2008) estimated in 2008/09 that Medupi and Kusile would be delivered at a cost of R150 billion. The final delivery date for the plant was initially estimated to be in 2011 (Eskom, 2008). Eskom's most recent estimate in 2016/17 is that the final unit of the programme will only be commissioned by 2022 and that the programme will cost R306 billion overall (Eskom, 2016). This translates into an 11-year delay and 104% cost overrun from the initial estimate prepared by Eskom (2008). This is the reason that none of the scenarios tested produce positive cash flows and an economic profit. This is because irrespective of the financial support provided to Eskom, the utility has incurred greater financing costs and done so over a much longer period of time than was initially planned for. What this means for the results of the cash flow modelling in all three scenarios is that Eskom does not have larger cash inflows from 2011 onwards due to the sales from the additional electricity produced from Medupi and Kusile. Instead, Eskom has had to take on more debt than initially planned for, which has in turn increased the utility's debt-service costs. This has further reduced the cash flow over the period. The debt taken on to finance these cost overruns has increased the capital employed by the utility and the weighted average cost of capital, both of which raise Eskom's capital charge. The combination of these effects explains the large economic losses reported in the results of all three scenarios.

The financial analysis results can also be explained by a failure to adhere to the principles of long-run marginal cost pricing advocated by Hotelling (1938) and Houthakker (1951), as discussed in subsection 3.1.1 of the literature review. Several studies such as Sebitosi (2010), Kohler (2014) and even Eskom (2017) have argued that Eskom's tariff is insufficient to pay for the debt the utility has incurred. This problem dates back to the last major capital expansion

that the utility undertook in the 1980s (Kantor, 1988). To pay back the debt incurred, Eskom instituted large tariff increases (Ibid). This led to a commission of inquiry that took a decision to strip Eskom of its tariff setting power. The commission also determined that replacement costs should not form part of the electricity tariff in order to limit future tariff increases (Ibid). As a result, the tariff is not fully reflective of the costs of producing electricity including the capital investments required (Steyn, 2006).

A further problem that Eskom faces is that its return-on-assets or profit is calculated by the regulator based on the historical value of the utility's existing assets. The most important assets in this calculation are the utility's power stations, of which the most recent was completed in the 1980s. According to Steyn (2006) and Newberry and Eberhard (2008), the use of the historical valuation of the power plants significantly underestimates the present-day cost of building a new power station. This is because it does not take into account inflation or technological improvements, which increase the cost of materials required to build a power station. Another possible factor that has been cited for Eskom's low returns is corruption in Eskom procurement (Steyn, 2006). It is beyond the scope of this study to discuss this issue.

5. Conclusion and policy recommendations

The broad aim of the study was to investigate the impact of public finance subsidies to Eskom on debt sustainability of the public finances. A second aim was to investigate whether public finance subsidies affected Eskom's financial performance between 2006/07 and 2016/17?

This study has policy relevance in the present day because at the time of writing, Eskom had about R105 billion left on its R350 billion government loan guarantee facility (National Treasury, 2019). It is important that given the severe financial difficulties the utility finds itself, the public finance authorities must evaluate whether it is prudent to allow Eskom to borrow further against this guarantee or, given the strong measures to reduce the primary deficit that have been undertaken since 2009/10, whether it would be feasible to fund the utility from the public finances since this would remain in line with the debt sustainability principle. Lewis and MacKinnon (1987) found that debt guarantees, especially to public utilities, create the risk that a firm may become over-indebted. One must be cautious, however, not to solely attribute the deterioration of Eskom's financial position to the fact that the utility did not receive subsidies. As has been discussed in in section 6.6 of this study, Eskom has been

buffeted by several external pressures which have reduced its return on invested capital. The results do however support the conclusion of Hofmans and van de Coevering (2014) that in instances where the return on invested capital is less than certain, the most appropriate public finance decision is to finance with a direct subsidy instead of issuing a government guarantee. The results in this study show that sequenced subsidies over a longer period would have been a better approach than providing a government guarantee to Eskom. If Eskom defaults on its guaranteed debt obligation, the entire guarantee is payable by the government. The fact that the value of the guarantee has consistently been greater than zero shows that bondholders believe that there is a possibility that Eskom will default on its obligations.

In this study, it has been established that public finance subsidies did not result in an unsustainable debt trajectory. Further, additional public finance subsidies to Eskom could have been provided in the place of the government guarantee, and this would not have been inconsistent with the fiscal objective of debt sustainability. However, public finance subsidies would have been insufficient for Eskom to earn an economic profit on the capital invested even if the utility's guaranteed debt were instead replaced by public finance subsidies.

The results presented above have broad policy implications for the conduct of South Africa's fiscal policy especially as it relates to the government's intervention in the electricity sector. The focus of these comments is narrowly related to the three fiscal principles of *debt-sustainability, inter-generational equity, and counter-cyclicality* as explained in subsection 3.1 of the literature review.

It can be seen from the results that public finance subsidies to Eskom did not violate the debt-sustainability principle because the fiscal reaction function has a positive and significant debt coefficient. Concerning counter-cyclicality, that the output gap coefficient of the fiscal reaction function was insignificant suggests that, in general, government fiscal policy was not counter-cyclical and that the subsidies to Eskom did not make a meaningful contribution to the fiscal objective of counter-cyclical fiscal policy.

The decision to provide Eskom with R91 billion in subsidies, it can be argued, was inconsistent with the principle of inter-generational equity except that the losses to future generations would have been much higher if Eskom had not been given support. This can be seen from

the results of the *no-support* scenario. Additional subsidies to the utility would have further reduced these losses, but it would still be hard to justify because Eskom would remain deeply value destructive based on the results of the *more-support* scenario.

A proposed solution to this problem of value destruction by the utility is to increase the electricity tariff to match the long-run marginal cost of electricity production. This solution is difficult to implement. Past attempts to increase tariffs to a cost-reflective level have received political resistance from unions and parts of government (Steyn, 2011; das Nair et al. 2014). Research has also suggested that if electricity tariffs rise too quickly, it would dampen economic activity (specifically industrial production) and impact South Africa's rate of economic growth (Altman et al. 2008). Lower economic growth could negatively harm debt-sustainability of the public finances. Large tariff increases also risk leading to higher inflation (South African Reserve Bank, 2017). This action by the regulator on behalf of Eskom would warrant a tightening of monetary policy by the central bank. This would raise interest rates and equally risk making the public debt unsustainable.

The results of this study should not be interpreted as suggesting that all capital expenditure programmes undertaken by state-owned companies (SOCs) should be fully subsidised by the public finances. The results also do not invalidate the government guarantee policy. It was noted in subsection 2.4 that a government guarantee is in effect a subsidy from the public finances with respect to the debt-service payments of the entity whose debt is guaranteed. Nor is it suggested that SOCs should not borrow from debt capital markets. Instead, the optimal capital mix of an SOC should also be informed by an analysis of the capacity of the public finances to fund the SOC without violating the fiscal objectives. As discussed in Section 2, in the post-World War II period, Eskom has had a significant reliance on debt.

7.1 Further research

Two simplifying assumptions were made in this investigation in order to focus on the relationship between debt-sustainability and subsidies for Eskom. An agenda for further research must include replication of these results with these assumptions relaxed. Concerning the debt-sustainability modelling, it was assumed in all scenarios that interest and economic growth rates were the same as they were in the *baseline* scenario. To an extent, this assumption can be considered reasonable because what was argued for in this study was that debt raised by Eskom should have instead been raised by the government. The overall impact

on the volume of public sector debt issuance would be neutral. In developing its debt issuance calendar, the National Treasury (2018) argued that investors view government and SOC debt as substitutes when building their portfolios¹³. Further research could consider these issues in turn: First, would interest rates have been higher had more support been given to Eskom? Second, to what extent do investors view SOC debt and government debt as substitutes when constructing investment portfolios? Third, because debt sustainability depends on nominal gross domestic product growth as much as it depends on the pace of debt accumulation, a follow-up investigation should explore whether the larger deficit and government debt would have affected growth and, in turn, what the implications for debt sustainability would be. This would recall the finding made by Reinhart and Rogoff (2010; 2011) that debt-to-GDP above a threshold level results in lower economic growth.

Finally, it is important to remember Modigliani and Miller's (1958) finding that capital structure does not have an impact on the value of a firm, which is discussed in subsection 3.1 of the literature review. In this study, it was found that altering Eskom's capital structure would have affected Eskom's value. The reduction in the utility's debt burden reduced the interest burden, which boosted overall net-operating and economic profit. At the same time, public finances reduce the utility's overall capital requirement by eliminating the necessity for Eskom to borrow just to pay interest. This study does not disprove Modigliani and Miller's findings because Eskom is a single case. Instead, the result of this investigation suggests two questions for further research: First, what is the predominant capital structure for SOCs in Africa and South Africa? Second, does the choice of capital structure materially reduce the profitability and valuation of SOCs compared to their privately-owned peers?

Finally, in this investigation, the notion of debt-sustainability as a fiscal principle for South Africa has not been questioned. It is worth mentioning however, that debt-sustainability as an explicit fiscal target is only a recent innovation (National Treasury, 2011). It is a concept rarely explicitly mentioned in National Treasury documents prior to 2011 and the publication of Reinhart and Rogoff (2011). The objective of this investigation was not to evaluate the origins or merits of debt sustainability but rather to emphasise the need for flexibility on the

¹³ It is for this reason that the rating agencies assign Eskom two ratings: the first based on its own debt fundamentals and a second based on the support it receives from government (S&P Global ratings, 2017; Moody's, 2017). The second rating is better than the first (Ibid).

part of public finance authorities in supporting SOC's while adhering to sound fiscal principles. Further research should, however, question the appropriateness of debt-sustainability as a fiscal objective, especially in light of the ambitious development targets set in the NDP

Bibliography

- Altman, M., Davies, R., Mather, A., Fleming, D. and Harris, H. (2008). The impact of electricity price increases and rationing on the South African economy. Final report to the National Electricity Response Team. *Human Sciences Research Council, Pretoria*
- Baker, L. (2011). Governing electricity in South Africa. *University of East Anglia. Working Paper Number 15.*
- Baldwin, C., Lessard, D. and Mason, S. (1983). Budgetary time bombs: controlling government loan guarantees. *Canadian Public Policy/Analyse de Politiques*, 9(3), 338-346.
- Biggs, M. (1996). *Does South Africa's government debt threaten the sustainability of fiscal policy*. University of Cape Town: Dissertation Manuscript.
- Black, F. and Scholes, M. (1973). The pricing of options and corporate liabilities. *The Journal of Political Economy*, 81(3), 637-654.
- Bloomberg (2017). *Company information of Eskom holdings SOC Ltd, s.l.*: Bloomberg subscription service.
- Bloomberg (2018). *Bloomberg Professional*. [Online] Available at: [Subscription Service](#) [Accessed 20 March 2018].
- Bohn, H. (1998). The behaviour of US public debt and deficits. *Quarterly Journal of Economics*, 113(3), 949-963.
- Bohn, H. (2007). Are stationarity and cointegration restrictions really necessary for the intertemporal budget constraint? *Journal of Monetary Economics*, 54(7), 1837-1847.
- Bowman-Gilfillan (2012). Eskom government guarantee support framework. February 2012. Retrieved from: <http://www.eskom.co.za/OurCompany/Investors/GovernmentGuarantees>.
- Brandao, L. E. and Saraiva, E., (2008). The option value of government guarantees in infrastructure projects. *Construction Management and Economics*, 1(26), 1171-1180.
- Burger, P. and Calitz, E. (2015). Twenty-year review of South African fiscal policy: A tale of two sustainabilities. *Development Southern Africa*, 32(6), 639-65.
- Burger, P., Siebrits, K. and Calitz, E. (2015). The public sector balance sheet and fiscal consolidation in South Africa. University of Stellenbosch. Working Paper Number 11.
- Burger, P., Stuart, I., Jooste, C. and Cuevas, A. (2012). Fiscal sustainability and the fiscal reaction function for South Africa: assessment of the past and future policy applications. *South African Journal of Economics*, 80(2), 209-227.
- Calitz, E. and Fourie, J. (2007). Infrastructure in South Africa: who is to finance and who is to pay? University of Stellenbosch. Working Paper Number 15.
- Carranza, L., Daude, C. and Melguizo, A. (2014). Public infrastructure investment and fiscal sustainability in Latin America: incompatible goals? *Journal of Economic Studies*, 41(1), 29-50.

- Cheah, C. Y. and Liu, J. (2006). Valuing governmental support in projects as real options using Monte Carlo simulation. *Construction Management and Economics*, 24(5), 545-554.
- Checherita-Westphal, C. and Vaclav, Z. (2017). Fiscal reaction function and fiscal fatigue: evidence for the euro area. *European Central Bank. Working Paper Number 2036*.
- Chen, J. (2005). The Determinants of Capital Structure: Evidence from Chinese Listed Companies. *Economic Change and Restructuring*, 38(1), 11-35.
- Das Nair, R., Montmasson-Clair, G. and Ryan, G. (2014). Regulatory Entities Capacity Building Project Review of Regulators Orientation and Performance: Review of Regulation in the Electricity Supply Industry. Centre for Competition, Regulation and Economic Development.
- De Mello, L. (2008). Estimating a fiscal reaction function: the case of debt sustainability in Brazil. *Applied Economics*, 40(3), 271-284.
- Department of Energy. (2011). *Integrated Resources Plan for Electricity 2010-2030*. Department Energy. Pretoria
- Department of Energy. (2013) *Integrated Resources Plan for Electricity 2010-2030 (2013 Update)*. Department Energy. Pretoria
- Department of Energy. (2014). *Annual Report*, Pretoria: Government Printing Works.
- Department of Minerals and Energy. (1998). *White paper on the energy policy of the Republic of South Africa*. Department of Minerals and Energy. Pretoria
- Easterly, W. (1999). When is fiscal adjustment an illusion? *Economic Policy*, 14(28), 56-86.
- Eskom. (1990). *1990 Annual Financial Statements*. Eskom SOC limited. Johannesburg.
- Eskom. (1992). *1992 Annual Financial Statements*. Eskom SOC limited. Johannesburg.
- Eskom. (2005). *2005/06 Annual Financial Statements*. Eskom SOC limited, Johannesburg.
- Eskom. (2008). *2007/08 Annual Financial Statements*. Eskom SOC limited. Johannesburg.
- Eskom. (2010). *2009/10 Integrated Report*. Eskom SOC limited. Johannesburg.
- Eskom. (2016). *2015/16 Annual Financial Statements*. Eskom SOC limited. Johannesburg.
- Eskom. (2016). *2015/16 Integrated Report*. Eskom SOC limited. Johannesburg. Johannesburg.
- Eskom. (2017). *2016/17 Annual Financial Statements*. Eskom SOC limited. Johannesburg.
- Eskom. (2017). *2018/19 Eskom Holdings Revenue Application*. National Energy Regulator of South Africa. Pretoria
- Fischer, S. and Easterly, W. (1990). The economics of the government budget constraint. *The World Bank Research Observer*, 5(2), 127-142.
- Gujarati, D. (2003). *Basic econometrics*. 4th edition. New York City. McGraw-Hill.
- Herndon, T., Ash, M. and Pollin, R. (2014). Does high public debt consistently stifle economic growth? A critique of Reinhart and Rogoff. *Cambridge Journal of Economics*, 38(2), 257-279.

- Hodrick, R. and Prescott, E. (1997). Post-war U.S. Business cycles: an empirical investigation. *Journal of Money Credit and Banking*, 29(1), 1-16.
- Hofmans, H. M. and van de Coevering, C. R. (2014). How to deal with contingent liabilities- lessons from the Dutch experience. *OECD Journal of Budgeting*, 14(1), 35-45.
- Hotelling, H. (1938). The general welfare in relation to problems of taxation and of railway and utility rates. *Econometrica*, 6(3), 242-269.
- Houthakker, H. S. (1951). Electricity tariffs in theory and practice. *The Economic Journal*, 61(241), 1-25.
- Huang, G. and Song, F. (2006). The determinants of capital structure: Evidence from China. *China Economic Review*, 17(1), 14-36.
- International Monetary Fund. (2011). *Modernizing the Framework for Fiscal Policy and Public Debt Sustainability Analysis*. The International Monetary Fund. Washington D.C.
- International Monetary Fund. (2013). *Staff Guidance Note for Public Debt Sustainability Analysis in Market-Access Countries*. The International Monetary Fund. Washington D.C.
- Kantor, B. (1988). The Pricing of Electricity in South Africa: A Critical Assessment of the De Villiers commission of inquiry. *Managerial and decision economics*, 9(4), 301-309.
- Keynes, J. M. (1936). *The General Theory of Employment, Interest and Money*. London. Palgrave Macmillan.
- Khan, M., Thopil, G., and Lalk, J. (2016). Review of proposals for practical power sector restructuring and reforms in a dynamics electricity supply industry, *Renewable and Sustainable Energy Reviews*, 62(1), 326-335.
- Kohler, M. (2014). Differential electricity pricing and energy in South Africa. *Energy*, 64(1), 524-532.
- Kolitz, D. L., Quinn, A. B. and McAllister, G. (2009). Recognition and measurement of the elements of the financial statements. In: D. Kolitz, 4th edition. *A Concepts-Based Introduction to Financial Accounting*. 4th edition Cape Town. Juta.
- Koller, T., Goedhart, M. and Wessels, D. (2010). *Valuation: Measuring and Managing the Value of Companies*. 5th edition. Hoboken. John Wiley and Sons, Inc.
- KPMG. (2014). *Sub-Saharan Africa Power Outlook*. KPMG. Johannesburg.
- Lewis, F. and MacKinnon, M. (1987). Government loan guarantees and the failure of the Canadian northern railway. *The Journal of Economic History*, 47(1), 175-196.
- Mahmood, K. and Malik, W. (2007). The Fiscal Reaction Function and the Transmission Mechanism for Pakistan. *Pakistan Development Review*, 4(46), 435-447.
- Marshall, A. (1895). *Principles of Economics*.: London. Macmillan and Co.
- Mas-Colell, A. Whinston, M. D. and Green, J. (1995). *Microeconomic Theory*. New York City. Oxford University Press.
- McKinsey Global Institute. (2015). *Brighter Africa: The Growth Potential of the Sub-Saharan Electricity Sector*. McKinsey & Company. San Francisco.

- McKinsey Global Institute. (2018). *How utilities can keep the lights on*. McKinsey & Company. San Francisco.
- Merton, R. (1977). An analytic derivation of the cost of deposit insurance and loan guarantees. *Journal of Banking and Finance*, 1(1), 3-11.
- Merton, R. (1977). On the pricing of contingent claims and the Modigliani-Miller theorem. *Journal of financial economics*, 1(3): 241-249.
- Miller, M. and Modigliani, F. (1966). Some estimates of the cost of capital to the electric utility industry, 1954-1957. *The American Economic Review*, 56(3), 333-391.
- Modigliani, F. and Miller, M. (1958). The cost of capital, corporation finance and the theory of investment. *The American Economic Review*, 48(3), 261-297.
- Modigliani, F. and Miller, M. (1963). Corporate income taxes and the cost of capital: a correction. *The American Economic Review*, 53(3), 433-443.
- Mody, A. and Patro, D. (1996). Valuing and accounting for loan guarantees. *The World Bank Research Observer*, 11(1), 119-142.
- Moody's. (2017). *Moody's places Eskom's Ba1/A2.za ratings on review*. Moody's Investor Service. London.
- M'pasi, A. (1995). *An application of an option pricing model to evaluate the cost of a government loan guarantee: a hypothetical case based on Eskom*. The University of Cape Town: Dissertation Manuscript.
- Myers, S. (1984). The capital structure puzzle. *The Journal of Finance*, 39(3), 574-592.
- Myers, S. and Majluf, N. 1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics*, 13(2), 197-221.
- Naraidoo, R. and Raputsoane, L. (2013). Debt Sustainability and Financial Crises in South Africa. University of Pretoria. Working Paper Number 52.
- National Planning Commission. (2012). *National Development Plan 2030 Our Future-make it work*. Government Printing Works. Pretoria.
- National Treasury. (2009). *2009 Budget Review*. Government Printing Works. Pretoria.
- National Treasury. (2010). *2010 Budget Review*. Government Printing Works. Pretoria.
- National Treasury. (2011). *2011 Medium Term Budget Policy Statement*, Government Printing Works. Pretoria.
- National Treasury. (2012). *2012 Budget Review*. Government Printing Works. Pretoria.
- National Treasury. (2015). *2015 Budget Review*. Government Printing Works. Pretoria.
- National Treasury. (2017). *2017 Budget Review*. Government Printing Works. Pretoria.
- National Treasury. (2018). *2018 Budget Review*. Government Printing Works. Pretoria.
- National Treasury. (2019). *2019 Budget Review*. Government Printing Works. Pretoria.
- Ncube, M. and Brixova, Z. (2015). Public Debt Sustainability in Africa: Building Resilience and Challenges Ahead. *Development Policy Review*, 555-580.

- Neck, R. and Sturm, J. (2008). Sustainability of public debt: introduction and overview. In: *Sustainability of Public Debt*.: Cambridge. MIT Press.
- NERSA. (2008). *Multi-year price determination methodology*. National Energy Regulator of South Africa. Pretoria.
- Newberry, D. and Eberhard, A. (2008). South African Infrastructure Review: Electricity. National Treasury. Pretoria.
- Paton, C. (2015). ANC determined to avoid P-word in Eskom's future. *Business Day*: 2.
- Pritchett, L. (2000). The tyranny of concepts: CUDIE (cumulated, depreciated, investment effort) is not capital. *Journal of Economic Growth*, 4(5), 361-384.
- Quintos, C. (1995). Sustainability of the deficit process with structural shifts. *Journal of Business and Economic Statistics*, 13(4), 409-417.
- Reinhart, C. and Rogoff, K. (2010). Growth in a time of debt. *American Economic Review*, 100(2), 573-78.
- Reinhart, R. and Rogoff, K. (2011). The forgotten history of domestic debt. *The Economic Journal*, 121(552), 319-350.
- Ross, S. A., Westerfield, W. and Jordan, D. (2008). *Corporate Finance Fundamentals*. New York City. McGraw-Hill/Irwin.
- S&P Global ratings. (2017). *South African Utility Eskom Holdings SOC Rating Lowered to 'B+' Following Sovereign Downgrade; Outlook Negative*. S&P Global ratings. New York City.
- Sasaki, D. and Nakayama, M. (2016). Effectiveness of public financial support in an electricity transmission project between Iceland and the UK. *Business and Management Studies*, 2(2), 14-20.
- Saxegaard, M., 2014. Safe debt and uncertainty in emerging markets: an application to South Africa. *International Monetary Fund. Working Paper Number 231*.
- Sebitosi, A. B. (2010). Is the South African electricity tariff model conducive to an energy efficient economy? *Energy for Sustainable Development*, 1(14), 315-319.
- Seymore, R., Akanabi, O. and Abedian, I. (2012). Macroeconomic impact of Eskom's six-year capital investment programme. *South African Journal of Economic and Management Sciences*, 15(2), 142-170.
- Sims, C. (1980). Macroeconomics and reality. *Econometrica*, 1(48), 1-48.
- South African Reserve Bank. (2017). *Institutional sector classification guide for South Africa*. South African Reserve Bank. Pretoria.
- South African Reserve Bank. (2018). *Monetary Policy Review*. South African Reserve Bank. Pretoria.
- Stadelmann, M. and Gianleo, F. (2015). De-risking concentrated solar power in emerging markets: The role of policies and international finance institutions. *Energy*, 82(1), 12-22.
- Steyn, G. (2006). Investment and uncertainty: historical experience with power sector investment in South Africa and its implications for current challenges. University of Cape Town. Working Paper.

- Steyn, G. (2011). The impact of economic regulation on the management and performance of State-Owned Enterprises. Meridian Economics, Cape Town.
- Styan, J., 2015. *Blackout: The Eskom Crisis*. 1st edition. Johannesburg. Jonathan Ball Publishers.
- Trehan, B. and Walsh, C. (1991). Testing intertemporal budget constraints: theory and applications to US federal budget and current account deficits. *Journal of Money, Credit and Banking*, 23(2), 206-223.
- Tsay, R. (2010). *Analysis of financial time series*. 3rd edition. Hoboken. John Wiley and Sons.
- Williams, J. and Ghanadan, R. (2006). Electricity reform in developing and transition economies: a reappraisal. *Energy*, 31(1), 815-844.
- Wyplosz, C. (2007). Debt Sustainability Assessment: The IMF Approach and Alternatives. Graduate Institute of International Studies. Geneva.

Appendix A: Assumptions used to model the Black analysis to estimate the fiscal cost of a guarantee

The table below presents the assumptions used to model the Black (1977)

Estimates of the equivalent public finance support from the Eskom government guarantee facility											
	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Inputs into the Black (1977) Model											
Face value of the guaranteed debt (B) (R Million)	133.0	100.0	100.0	46 678.0	67 057.0	77 230.0	103 523.0	125 125.0	149 944.0	174 586.0	218 000.0
Value of the Eskom's assets reported in the balance sheet (A) (R Million)	128 152.0	143 312.0	171 181.0	199 302.0	246 135.0	328 145.0	382 365.0	432 024.0	504 993.0	557 945.0	663 170.0
Average maturity period of the guaranteed debt (t) (years)	22.5	8.0	17.7	23.2	17.7	11.8	15.2	13.3	14.3	14.5	14.2
Compounded Risk-Free Interest Rate (rf)	8.00%	8.15%	8.80%	8.94%	8.52%	8.41%	7.64%	8.01%	8.00%	8.61%	8.85%
Standard Deviation (annualized s)	2.00%	6.83%	17.18%	9.48%	12.01%	13.53%	11.99%	17.14%	12.80%	19.03%	13.26%
Outputs from the Black (1977) Model											
Annual additional fiscal support	-	-	0.0	41 565.2	127.6	-	24 878.6	13 026.6	12 349.5	34 846.2	21 605.1
Cumulative additional fiscal support	-	-	0.0	41 565.2	41 692.7	41 692.7	66 571.3	79 597.9	91 947.4	126 793.6	148 398.7

Source: Author's calculations using bloomberg and Eskom data

Appendix B: Pre and Post-estimation test results for the fiscal sustainability analysis

This section presents the supporting pre and post analysis used to build the fiscal reaction function tests for sustainability.

Baseline scenario fiscal reaction function (FRF)

The results of the Augmented Dickey-Fuller tests and Phillips-Perron tests are shown in the table below. The debt and primary balance series are non-stationary in level forms, but are first difference stationary. This means in level form both series have a unit roots. This means that once more both the debt and primary balance time series are integrated of order 1.

Results of tests for unit roots in the baseline scenario¹

Levels	Primary Balance (% of GDP)	Debt stock (% of GDP)
Augmented Dickey-Fuller	0.188	0.513
Phillips-Perron	0.666	0.961
First-difference		
Augmented Dickey-Fuller	0.000	0.001
Phillips-Perron	0.000	0.006

1. All tests are reported at the 5 per cent significance level

Source: author's calculations

The results of the lag selection criteria are shown in the table below. These results confirm that the optimal lag of the model is 1, as is the case with the previous studies using an FRF discussed in the literature review.

Lag length selection

Model	Lag length	FPE	AIC	HQIC	SBIC
debt; pb;					
temporary expenditures ¹ ; output gap ¹	1	.000023*	-5.00052*	-4.87845*	-4.63773*

1.indicates exogenous variables

*indicates optimal lag order selected by the criteria

Source: author's calculations

The results of the post-estimation tests are shown in the tables below. From these estimates, it can be concluded that the estimated fiscal reaction function for the scenario is well specified in that it produces normally distributed error terms, does not exhibit autocorrelation, and has stable coefficients.

Post-estimation tests

	Jarque-Bera ¹	Lagrange-multiplier ²
p-value	0.57178	0.49673

1. Jarque-Bera test: H_0 residuals are normally distributed

2. Lagrange-multiplier test: H_0 no autocorrelation at lag order 1

source: author's calculations

Eigenvalue stability condition

Eigenvalue	Modulus
0.8576536	0.862398
0.8576536	0.862398

All the eigenvalues lie inside the unit circle.

VAR satisfies stability condition.

source: author's calculations

As a final step, the long-run association between the primary balance and the debt stock or long run sustainability is determined. The table shows the results of the Johansen tests for cointegration, which indicate the presence of at least one cointegrating equation. This indicates a long-run relationship between the primary balance and the debt-to-GDP ratio.

Johansen test for cointegration

H_0 : Number of cointegrating relationships	eigenvalue	trace statistic	5% critical value	decision
0	.	19.1249	12.53	reject H_0 *
1	0.42098	0.0004*	3.84	accept H_0

* H_0 maximum number of cointegrating equations is at most the number indicated in the far left column

source: author's calculations

Since the results of the Johansen tests show a cointegration relationship then the vector-error-correction mechanism for the scenario shown in the main text is valid.

The post-estimation tests for the estimated vector error correction mechanism are presented in the tables below and show that the estimated VECM produces residuals that are normally distributed and are serially uncorrelated.

VECM post-estimation tests

	Jarque-Bera ¹	Lagrange-multiplier ²
p-value	0.45678	0.76236

1. Jarque-Bera test: H_0 residuals are normally distributed

2. Lagrange-multiplier test: H_0 no autocorrelation at

source: author's calculations

Eigenvalue stability condition

Eigenvalue	Modulus
	1
.555481 + .1198113i	0.568255
.555481 - .1198113i	0.568255
0.1632153	0.163215

The VECM specification imposes a unit modulus

source: author's calculations

No-support scenario

The results of the Augmented Dickey-Fuller tests and Phillips-Perron tests are shown in the table below. The debt and primary balance series are non-stationary in level forms but are first difference stationary. This means in level form both series have a unit roots. This means that once more both the debt and primary balance time series are integrated of order 1.

Results of tests for unit roots in the *no-support* scenario¹

Levels	Primary Balance (% of GDP)	Debt stock (% of GDP)
Augmented Dickey-Fuller	0.464	
Phillips-Perron	0.394	0.928
First-difference		
Augmented Dickey-Fuller	0.000	0.005
Phillips-Perron	0.000	0.000

1. All tests are reported at the 5 per cent significance level

Source: author's calculations

The results of the lag selection criteria are shown in the table below. These results confirm that the optimal lag of the model is 1, as is the case with the previous studies using an FRF discussed in the literature review.

Lag length selection in the no-support scenario

Model	Lag length	FPE	AIC	HQIC	SBIC
debt; primary balance; temporary expenditures ¹ ; output gap ¹	1	1.6e-07*	-9.96278*	-9.84132*	-9.59635*

1.indicates exogenous variables

*indicates optimal lag order selected by the criteria

Source: author's calculations

The results of the post-estimation tests are shown in the tables below. From these estimates, it can be concluded that the estimated fiscal reaction function for the scenario is well specified in that it produces normally distributed error terms, does not exhibit autocorrelation, and has stable coefficients.

Post-estimation tests

	Jarque-Bera ¹	Lagrange-multiplier ²
p-value	0.52231	0.64087

1. Jarque-Bera test: H_0 residuals are normally distributed

2. Lagrange-multiplier test: H_0 no autocorrelation at lag order 1

Source: author's

Eigenvalue stability condition

Eigenvalue	Modulus
0.9582111	0.9582111
0.7750742	0.7750742

All the eigenvalues lie inside the unit circle.

VAR satisfies stability condition.

Source: author's calculations

Since the results of the Johansen tests show a cointegration relationship then the vector-error-correction mechanism for the scenario is valid.

Johansen tests for cointegration

H ₀ :Number of cointegrating relationships	eigenvalue	trace statistic	5% critical value	decision
0	.	29.2274	15.41	reject H ₀ *
1	0.40685	0.0029*	3.84	accept H ₀

*H₀ maximum number of cointegrating equations is at most the number indicated in the far left column

Source: author's calculations

The post-estimation tests for the estimated vector error correction mechanism are presented in the tables below and show that the estimated VECM produces residuals that are normally distributed and are serially uncorrelated.

VECM post-estimation tests

	Jarque-Bera ¹	Lagrange-multiplier ²
p-value	0.62707	0.58968

1. Jarque-Bera test: H₀ residuals are normally distributed

2. Lagrange-multiplier test: H₀ no autocorrelation at

Source: author's calculations

Eigenvalue stability condition

Eigenvalue	Modulus
	1
.5810611 + .1953006i	0.613004
.5810611 - .1953006i	0.613004
0.1170337	0.117034

The VECM specification imposes a unit modulus

Source: author's calculations

More-support scenario

Estimating the fiscal reaction function for the *more-support* scenario

The results of the Augmented Dickey-Fuller tests and Phillips-Perron tests are shown in the table below. The debt and primary balance series are non-stationary in level forms but are first difference stationary. This means in level form both series have a unit roots. This means that once more both the debt and primary balance time series are integrated of order 1.

Results of tests for unit roots in the more-support scenario¹

Levels	Primary Balance (% of GDP)	Debt stock (% of GDP)
Augmented Dickey-Fuller	0.415	0.983
Phillips-Perron	0.350	0.888
First-difference		
Augmented Dickey-Fuller	0.000	0.006
Phillips-Perron	0.000	0.005

1. All tests are reported at the 5 per cent significance level

Source: author's calculations

The results of the lag selection criteria are shown in the table below. These results confirm that the optimal lag of the model is 1, as is the case with the previous studies using an FRF discussed in the literature review.

Lag length selection

Model	Lag length	FPE	AIC	HQIC	SBIC
debt; primary balance; temporary expenditures ¹ ; output gap ¹	1	2.2e-07*	-9.64578*	-9.52432*	-9.27935*

1. indicates exogenous variables

*indicates optimal lag order selected by the criteria

Source: author's calculations

The results of the Jarque-Bera and Lagrange-multiplier post estimation tests are shown in tables below. The estimated fiscal reaction function is well specified and stable; it produces residuals that are serially uncorrelated.

Post-estimation tests

	Jarque-Bera ¹	Lagrange-multiplier ²
p-value	0.01975	0.37551

1. Jarque-Bera test: H_0 residuals are normally distributed

2. Lagrange-multiplier test: H_0 no autocorrelation at lag order 1

Source: author's calculations

Eigenvalue stability condition

Eigenvalue	Modulus
0.9674496	0.9674496
0.7775863	0.7775863

All the eigenvalues lie inside the unit circle.

VAR satisfies stability condition.

Source: author's calculations

The Johansen cointegration test results are shown in the table are shown below the primary balance and debt time series are cointegrating, with one cointegrating equation between them.

Johansen tests for cointegration

H₀:Number of cointegrating relationships	eigenvalue	trace statistic	5% critical value	decision
0	.	29.2067	15.41	reject H ₀ *
1	0.54267	1.8245*	3.76	accept H ₀

*H₀ maximum number of cointegrating equations is at most the number indicated in the far left column

Source: author's calculations

Since the results of the Johansen tests show a cointegration relationship then the vector-error-correction mechanism for the scenario, shown in the main text is valid.

The post-estimation tests for the estimated vector error correction mechanism are presented in the tables below and show that the estimated VECM produces residuals that are normally distributed and are serially uncorrelated.

VECM post-estimation tests

	Jarque-Bera¹	Lagrange-multiplier²
p-value	0.45678	0.76236

1. Jarque-Bera test: H₀ residuals are normally distributed

2. Lagrange-multiplier test: H₀ no autocorrelation at

Source: author's calculations

Eigenvalue stability condition

Eigenvalue	Modulus
	1
.555481 - .1198113i	0.568255
.5810611 - .1953006i	0.613004
0.1632153	0.117034

The VECM specification imposes a unit modulus

Source: author's calculations

Appendix C: Assumptions for financial analysis and economic value analysis

This section presents of the annual breakdown and assumptions used to model the cash flow values for each scenario presented in table 6 in the main text.

Results of baseline scenario financial modelling

Discounted cash flow and economic profit analysis

	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	Cumulative value over the period
R million/per cent												
Net operating profit after tax	6 481.00	932.00	9 705.00	3 642.00	8 356.00	13 248.00	5 183.00	7 089.00	200.00	5 151.00	888.00	60 875.00
Free cashflow												
Free cashflow	-3 624.0	-16 427.0	9 489.0	-39 131.0	-27 118.0	-23 651.0	-35 710.0	-40 595.0	-40 215.0	-37 532.0	-37 478.0	-291 992.0
Discounted free cash flows	-3 471.0	-14 279.5	7 217.8	-26 673.4	-16 543.1	-12 587.6	-19 588.2	-22 216.0	-18 664.7	-14 385.8	-13 522.6	-154 714.0
Economic profit												
Invested capital	66 670.0	86 712.0	116 880.0	142 506.0	206 580.0	229 068.0	270 115.0	347 384.0	392 869.0	423 800.0	509 298.0	
Capital charge ¹	6 008.2	8 489.2	13 516.5	16 490.6	23 981.3	27 832.8	26 143.7	29 074.8	37 130.0	45 012.9	51 925.1	285 605.1
Economic profit	472.8	-7 557.2	-3 811.5	-12 848.6	-15 625.3	-14 584.8	-20 960.7	-21 985.8	-36 930.0	-39 861.9	-51 037.1	-224 730.1
<i>Weighted average cost of capital(WACC)</i>	9.0%	9.8%	11.6%	11.6%	11.6%	12.2%	9.7%	8.4%	9.5%	10.6%	10.2%	

1. calculated by multiplying invested capital by the WACC value
Source: author's calculations using Eskom and Bloomberg data

Results of the *no-support* scenario financial modelling

Discounted cash flow and economic profit analysis

	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	Cumulative value over the period
R million/per cent												
Net operating profit after tax	6 481.00	932.00	9 705.00	3 642.00	7 594.04	10 831.99	345.64	1 929.15	-5 270.24	-349.51	-6 472.98	29 368.08
Free cashflow												
Free cashflow	-3 624.0	-16 427.0	9 489.0	-39 131.0	-28 472.6	-27 946.1	-44 309.8	-49 768.1	-49 939.9	-47 310.7	-50 564.2	-348 004.3
Discounted free cash flows	-3 471.0	-14 279.5	7 217.8	-26 673.4	-17 395.9	-14 969.0	-24 416.7	-27 749.9	-22 992.4	-17 982.5	-18 316.1	-181 028.6
Economic profit												
Invested capital	66 670.0	86 712.0	116 880.0	142 506.0	207 638.3	232 423.6	276 833.6	354 550.5	400 466.6	431 439.6	519 521.6	
Capital charge ¹	6 008.2	8 489.2	13 516.5	16 490.6	24 025.7	27 937.8	26 580.7	28 718.3	38 263.3	46 245.8	52 753.2	289 029.2
Economic profit	472.8	-7 557.2	-3 811.5	-12 848.6	-16 431.7	-17 105.8	-26 235.0	-26 789.1	-43 533.5	-46 595.3	-59 226.2	-259 661.1
<i>Weighted average cost of capital(WACC)</i>	9.0%	9.8%	11.6%	11.6%	11.6%	12.0%	9.6%	8.1%	9.6%	10.7%	10.2%	

1. calculated by multiplying invested capital by the WACC value
Source: author's calculations using Eskom and Bloomberg data

Results of the *more-support* scenario financial modelling

Discounted cash flow and economic profit analysis

	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	Cumulative value over the period
R million/per cent												
Net operating profit after tax	6 481.00	932.00	9 705.00	3 642.00	11 325.51	16 605.67	8 544.38	12 456.16	6 603.23	12 588.61	11 144.32	100 027.88
Free cashflow												
Free cashflow	-3 624.0	-16 427.0	9 489.0	-39 131.0	-21 838.9	-17 681.8	-29 734.2	-31 053.4	-28 831.5	-24 309.6	-19 244.5	-222 386.9
Discounted free cash flows	-3 471.0	-14 279.5	7 217.8	-26 673.4	-13 242.0	-9 325.1	-16 256.7	-16 654.8	-13 513.2	-9 428.5	-6 904.1	-122 530.5
Economic profit												
Invested capital	66 670.0	86 712.0	116 880.0	142 506.0	202 455.7	224 404.6	265 446.4	339 929.6	383 975.6	413 470.0	495 053.1	
Capital charge ¹	6 008.2	8 489.2	13 516.5	16 490.6	23 807.4	27 684.5	25 839.3	29 443.2	35 804.9	43 347.1	50 770.2	281 201.2
Economic profit	472.8	-7 557.2	-3 811.5	-12 848.6	-12 481.9	-11 078.9	-17 294.9	-16 987.0	-29 201.7	-30 758.4	-39 625.9	-181 173.3
<i>Weighted average cost of capital(WACC)</i>	9.0%	9.8%	11.6%	11.6%	11.8%	12.3%	9.7%	8.7%	9.3%	10.5%	10.3%	

1. calculated by multiplying invested capital by the WACC value
Source: author's calculations using Eskom and Bloomberg data