IMPACT OF TARGETED INFRASTRUCTURE INVESTMENT ON ECONOMIC GROWTH AND EMPLOYMENT IN SOUTH AFRICA

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ABSTRACT

Infrastructure investment is key to stimulating economic growth, increasing employment, and reducing inequality. Increasing both private and public sector investment has been a strategy taken by several countries to stimulate economic recovery in the post-lockdown era. To realise the National Development Plan (NDP) investment goals, South Africa is advancing infrastructure investment as an avenue through which long-term economic and social goals can be obtained. This paper empirically assesses the impact of infrastructure investment on economic growth and employment. Specifically, this paper investigates the potential impact of the remaining infrastructure investment allocation in the R100 billion Infrastructure Fund. Scenarios are created in which the share of investment made towards several sectors is adjusted to determine which distribution of investment could yield the greatest impact. From the results, it can be concluded that infrastructure investment can stimulate both economic growth and employment creation, with the largest gains expected in the secondary sector. The greatest impact on gross domestic product (GDP) and employment is achieved when the bulk of the investment is allocated towards utilities, including electricity and water infrastructure. The paper provides empirical evidence to motivate for targeted infrastructure investment directed at sectors which yield the greatest impact on economic growth and employment.

Keywords: Infrastructure impact, Infrastructure investment, Economic growth, Employment, Infrastructure Fund

INTRODUCTION

It is widely agreed among academics and policymakers that public infrastructure is critical to the functioning of economies. Infrastructure investment is seen as a key lever to stimulating economic growth, increasing employment, and reducing inequality. Evidence suggests that it can boost short-term demand and raise long-term productivity. In line with post-apartheid objectives of stimulating inclusive economic growth, South Africa developed several policy documents which all propose infrastructure investment as a lever to achieving growth objectives. These policies include the Reconstruction and Development Programme (RDP), the Growth, Employment and Redistribution (GEAR) Macroeconomic Strategy, the Accelerated and Shared Growth Initiative for South Africa (ASGISA), and the more recent National Development Plan (NDP), Economic Reconstruction and Recovery Plan (ERRP), and National Infrastructure Plan (NIP) 2050.

Despite the repeated acknowledgement of infrastructure's role in growing the economy, infrastructure investment in the country has been slow and inefficient owing to issues in the construction sector itself, as well as challenges in the preparation and implementation of infrastructure projects. Some of the contributing factors to slow infrastructure investment include poor project preparation, a lack of capacity of procuring and implementing agents, and delays in the implementation of construction projects. In the construction sector itself, many large and small-scale construction firms have been forced to exit the industry owing to a lackluster demand for construction activities and a deterioration in profitability. These outcomes, along with other operational and policy-related challenges, have limited the gains from the implementation of the above-mentioned policy documents. Recent decisions to create Infrastructure South Africa (ISA) as a centralised government investment agency, publish the National Infrastructure Plan (NIP) 2050 and operationalise the Infrastructure Fund – designed to facilitate blended finance solutions and co-financing mechanisms to increase investment – are expected to support post-pandemic recovery.

The study therefore aims to examine empirically the potential impact of the R100 billion Infrastructure Fund's remaining investment value into economic and social infrastructure on gross domestic product (GDP) and employment. The impact is assessed across several sectors to motivate for infrastructure investment into projects within sectors where the greatest impact will be realised. This will be explored through an investment scenario-based analysis using the Energy-Environment-Economy Macro-Econometric Model (E3ME) developed by the European Commission's research framework and by Cambridge Econometrics.

The remainder of the paper is structured as follows: the literature review provides the background into South Africa's relevant policy landscape, infrastructure initiatives and related progress. The research methodology section outlines the mechanisms of the E3ME model and the research scenarios, followed by a section on results, while policy implications and study limitations are covered as conclusions.

LITERATURE REVIEW

Infrastructure investment is seen as key to stimulating economic growth, increasing employment, and reducing inequality. There are various channels through which infrastructure can impact economic growth. Kumo (2012) notes that infrastructure is a direct input into production processes, therefore serving as a factor of production. Furthermore, infrastructure is a complement to other inputs into the production process, lowering the cost of production but also stimulating factor accumulation by facilitating human capital development. It also boosts aggregate demand by increasing expenditure during the construction and maintenance of operations. Finally, it can serve as a tool to guide industrial policy which focuses on investing in specific infrastructure projects with the intention of guiding private-sector investment decisions (Fedderke and Garlick, 2008; Kumo, 2012).

Impact of GDP and Employment: Other Countries

Despite the fundamental role of public infrastructure in the functioning and expansion of economies, theoretical and empirical research to support this was not undertaken until the late 1980s (Munnell, 1992; Bougheas et al., 1999; Calderon and Serve, 2010). According to Munnell (1992), this work was triggered by David Aschauer who assessed the impact of public capital investment on output by estimating regressions that incorporate public capital as an additional variable to the production function. Aschauer's initial work concludes that "*much of the decline in U.S. productivity that occurred in the 1970s was precipitated by declining rates of public capital investment"* (Munnell, 1990). Early studies applying this approach to econometric equations found that the impact of aggregate public capital investment on private sector output and productivity is significant (Munell, 1990). Specifically, Aschauer finds evidence in his initial study that a one per cent increase in public capital investment will lead to an increase in private sector output by 0.39 per cent (Munnell, 1990). Several criticisms were levelled against these earlier estimates, reflecting concerns among academics about the large estimated coefficients, the spurious correlation and potential endogeneity associated with the variables (Munnell, 1990; Aakar et al., 2017). Subsequent studies have refined econometric techniques and sought to resolve the challenges raised.

Over the period 1960-1996, Ferreira and Araujo (2006) used Brazil's infrastructure investments in paved roads, telephone lines and electricity generation capacity to investigate the impact of the investment flows on capital variation (or the stock of capital) and growth. Using elasticities, the authors found a positive impact of each case of physical infrastructure investment on the expansion of each type of infrastructure. Other studies confirm the long-term relationships between infrastructure investment and growth. Using ordinary least squares (OLS) and instrumental variable estimation (IV) models, Bougheas et al. (2000) introduced physical infrastructure as a technology that enables the reduction in the fixed cost of producing intermediate inputs. This is in contrast to the older body of research that assumed capital as an exogenous variable in the production function. The study finds that (i) for the United States economy, the degree of specialisation in manufacturing is positively correlated with core infrastructure, and (ii) cross-country growth regressions show a positive impact between infrastructure and long-run growth.

Using correlation matrices, cointegration analysis and vector autoregression (VAR) models, Ferrira and Araujo (2006) assessed the long-run association between output and infrastructure over the period 1960-1996. Correlations between investment in physical infrastructure (roads, telephone lines and electricity generation) and output were found to be close to 1. The results of the regressions show that a 10 per cent increase in the stock of public infrastructure would raise long-run output per capita by between 2.2 and 3.3 per cent. Heintz et al. (2009) estimated a production function using the autoregressive-distributed lag (ARDL) model for the United States of America (USA) over the period 1951 – 2006. The results show that there is a long-run relationship between public capital and private productivity, with infrastructure having a crowding-in effect on private investment.

Changes in economic output tend to occur in parallel with changes to employment given that an increase in the production of goods and services requires an increase in the demand for labour. Several authors have also assessed the direct employment effect of infrastructure investment. Moszoro (2021) used firm-level panel data from 41 countries over 19 years to assess the direct employment impact of a USD 1 million infrastructure investment and maintenance in electricity, roads, schools and hospitals, and water and sanitation in advanced, emerging, and low-income developing economies. The author used marginal pass-through from spending on public investment to employment by regressing employment on revenues by sector and country income group at the individual firm level. The results show that three to seven jobs are created in advanced economies, ten to seventeen jobs in emerging market economies, and sixteen to thirty jobs in low-income developing countries when USD 1 million is invested into each economy.

International Monetary Fund (IMF) researchers find that among the Organization for Economic Cooperation and Development (OECD) countries, an increase in public investment of 1 percentage point of GDP generally results in a decrease in the unemployment rate by 0.11 per cent in the short term and 0.35 per cent in the medium term (Abiad et al., 2016). Further, research by Demetriades et al. (2015) estimated the impact of increased public capital on labour demand, using an intertemporal optimisation framework. The findings reveal that in the USA a 1 per cent increase in public capital increases labour demand by 1.13 per cent in the short term, 1.07 per cent in the medium term, and by 0.08 per cent in the long term.

2.2. Impact of GDP and Employment: South Africa

The impact of investment on economic growth in the South African context has also been widely explored. Kumo (2012) employed the VAR methodology and used Granger causality tests to test the relationships empirically among economic infrastructure investment, economic growth, and employment in South Africa between 1960 and 2009. He found that a strong, positive bi-directional causal relationship exists between infrastructure investment and growth. This result also holds for infrastructure investment and public sector employment owing to increased activity in construction, operations and maintenance. The author noted that although infrastructure investment has the potential to address poverty through employment creation, this potential is often not realised since projects are often equipment-intensive and rely on foreign contractors. It is therefore crucial for policymakers to ensure that economic objectives do not take precedence over social objectives and that local job creation remains at the centre of policy decisions.

While the Kumo (2012) study considers infrastructure spending in aggregate, Fedderke et al. (2006) disaggregated spending by type of economic infrastructure to determine which type of infrastructure has a material impact on growth in South Africa. The Pesaran, Shin and Smith (2001) (PSS) F-Test results suggest that railway goods stock, locomotives, unpaved and paved roads, goods and passenger vehicles, and electricity generation have a statistically significant impact on aggregate output.

To quantify the extent to which increased public economic infrastructure investment impacts social and economic indicators such as employment and economic growth, Mbanda and Chitiga-Mabuga (2016) utilised a dynamic computable general equilibrium (CGE) model and the Statistics South Africa (Stats SA) 2005 South Africa Social Accounting Matrix (SAM). Using simulated increases in aggregate infrastructure investment financed through government deficit, taxation, and a combination of both, the authors showed that improved public infrastructure investment reduces unemployment through higher labour demand, and lowers price levels while stimulating economic growth. They further showed that investment into economic infrastructure positively spills over into other sectors. This is through increased intermediate demand for commodities produced by other sectors, especially sectors with the strongest forward linkages with the public economic sector, such as construction and equipment manufacturing. Economic infrastructure investment positively impacts growth more generally in most sectors through a reduction in marginal costs.

Du, Zhang and Han (2022) similarly argue that infrastructure investment has both a direct and indirect macro-level impact in that it is an input factor, by increasing intermediate demand and total factor productivity (TFP). Infrastructure expansion also has a micro-level impact in that it can improve a firm's technical efficiency by reducing its inventory and operating costs.

Kularatne (2006) studied both economic and social infrastructure spending in South Africa by utilizing PSS ARDL methodology. The PSS F tests established that both economic and social infrastructure investment have a positive and statistically significant impact on growth. A vector error correction model (VECM) was used to show that public economic infrastructure investment has a multiplier of 1.02 on per capita GVA. Furthermore, a one per cent increase in social infrastructure investment resulted in a 0.06 per cent increase in per capita GDP. The author argued that social infrastructure spending, such as education and health infrastructure expenditure, has a positive impact on growth by improving the productivity of the labour force and providing beneficial outcomes to society. In essence, positive externalities are generated through a healthier and more educated population.

2.3. Investment Drive: South Africa

Given the impact that infrastructure investment can have on economic growth and employment, it is not surprising that it has been a strategy pursued by policymakers in South Africa. Following the abolishment of apartheid, several key policy documents have been developed to provide guidance on stimulating inclusive economic growth to meet the evolving needs of the country. These include the Reconstruction and Development Programme (RDP), adopted pre-1994 elections; the Growth, Employment and Redistribution (GEAR) Macroeconomic Strategy, introduced in 1996; the Accelerated and Shared Growth Initiative for South Africa (AsgiSA), published in 2006; the more recent National Development Plan (NDP), published in 2012; and the Economic Reconstruction and Recovery Plan (ERRP), published in 2020. Each publication proposes pursuing infrastructure investment to facilitate economic growth and address pressing socioeconomic needs.

In the initial years following the demise of apartheid, infrastructure investment was directed towards increasing access to social infrastructure, specifically housing, education, health care and basic services for historically disadvantaged individuals. The underlying rationale was that providing these necessary basic services would unlock previously suppressed economic and human potential in various areas of the country (South African Government, 1992). This would in turn modernise infrastructure and human resource development and increase the output in all sectors of the economy, leading to economic growth. GEAR and AsgiSA took a similar approach to the RDP but encouraged an acceleration in public sector infrastructure expenditure to address the backlogs and service deficiencies and introduced the concept of harnessing private sector infrastructure investment.

In recent policy documents, the need for infrastructure investment has shifted towards economic, strategic and catalytic infrastructure which can unlock economic opportunities and further harness private-sector investment and expertise through private-public partnerships (PPPs). This is captured in the NDP, which provides a long-term strategy for eliminating poverty and reducing inequality in the country by 2030 (National Planning Commission, 2012). This policy proposal highlights the ability of infrastructure investment to provide citizens with a means to improve their own lives and boost their incomes.

2.4. Infrastructure Commitments and Focus Areas

The NDP sets out objectives and actions in Chapter 4 (Economic Infrastructure), Chapter 6 (Inclusive Rural Economy) and Chapter 8 (Transforming Human Settlements) of the document aimed at improving infrastructure in the country. Priority areas for investment include transport and port capacity, energy, water and sanitation, housing and broadband access. The NDP commits to a gross fixed capital-to-GDP target ratio of 30 per cent by 2030, with public investment reaching 10 per cent of GDP. The NDP states that the role of government in infrastructure provision should be in the provision of social infrastructure which would not generate financial returns, the regulatory and governance space, and the provision of some financial assistance by offering guarantees and selective subsidies (National Planning Commission, 2012). Furthermore, it states that in the long run, the user-pay principle should be applied to economic infrastructure, with protection offered to poor households.

The ERRP reiterates the need for infrastructure investment and delivery, stating that it is one of the leading priority interventions to achieving the reform agenda (South African Government, 2020). Specifically, it states that a large-scale infrastructure programme can boost aggregate demand, assist in reviving the construction sector and increase employment. The ERRP emphasises the need to crowd in private investment into infrastructure through PPPs and blended finance. As a concept, blended finance utilises development or public finance to unlock additional funding support through the private sector to fund projects that have a social impact, can generate financial returns and will stimulate economic growth. The public sector contribution acts as gap funding and incentivises private involvement by de-risking investment into infrastructure projects (South African National Treasury, 2022).

The ERRP builds on the NDP and emphasises the need to improve the state's technical, project preparation and financial engineering capabilities. It also acknowledges the importance of utilising existing expertise in the private sector. One of the commitments made in the 2020 ERRP was to create Infrastructure South Africa (ISA) to act as a centralised government agency responsible for coordinating and implementing the infrastructure investment programme (South African Government, 2020). ISA was established in May 2020 and is currently housed as a programme within the Ministry of Public Works and Infrastructure (Development Bank of Southern

Africa, 2018). The role of ISA is to fast-track the delivery of catalytic social and economic infrastructure projects and oversee the project preparation, appraisal, and evaluation required to package a credible and market-ready infrastructure project pipeline (Infrastructure South Africa, 2022). Additionally, ISA aims to clear policy and regulatory blockages that prevent the development and implementation of infrastructure projects in the country. It is envisaged that ISA will facilitate the roll-out of South Africa's Infrastructure Investment Plan and the National Infrastructure Plan (NIP) 2050. The NIP 2050 aims to create a foundation for achieving the NDP's vision of inclusive growth and target of 30 per cent investment to GDP ratio.

ISA's mandate stretches across three main areas: (i) investment facilitation, (ii) the creation of a pipeline of public sector infrastructure, and (iii) improving the ease and cost of doing business. ISA also plays a central role in supporting the Infrastructure Fund, which was first announced by President Cyril Ramaphosa in 2018 as a means to utilise blended finance and co-financing mechanisms to increase investment and facilitate the delivery of socio-economic infrastructure programmes and projects in the country (Infrastructure South Africa, 2022).

The Infrastructure Fund, which is a collaboration between the National Treasury of South Africa (National Treasury), ISA, the Development Bank of Southern Africa (DBSA) and project owners, was established in 2020. The National Treasury has provided seed funding of R100 billion over ten years into the Infrastructure Fund to unlock private sector investment and infrastructure delivery in the country. The Infrastructure Fund Implementation Unit (IFIU), a ring-fenced division housed within the DBSA, assists with structuring infrastructure projects such that they can utilise a variety of capital from the private sector institutional investors, multilateral development banks and development finance institutions. To obtain portions of the funding from the Infrastructure Fund, projects or programmes have to be submitted to the Budget Facility for Infrastructure (BFI) in the National Treasury for appraisal. Once projects or programmes have been appraised and are deemed to fulfil the assessment criteria, funding can be allocated through the Infrastructure Fund. Since the inception of the Infrastructure Fund, R3 billion has been allocated to infrastructure project/programme implementation. This includes projects which have received funding and projects or programmes approved until the fifth window of the BFI (2021). These projects include four student housing infrastructure projects delivering 9 500 beds (R900 million), one social housing programme (R304.5 million) and the Lepelle Northern Water project (R1.4 billion).

2.5. Continued Failure to Deliver Infrastructure

Despite the acknowledgement of its importance, infrastructure investment has been slow and inefficient, characterised by, among other issues, project delays, under-budgeting and over-expenditure, and widespread corruption in both the tendering and expenditure components of infrastructure delivery. Investment as a share of GDP has remained well below the NDP target, measuring 13.1 per cent of GDP in 2021.

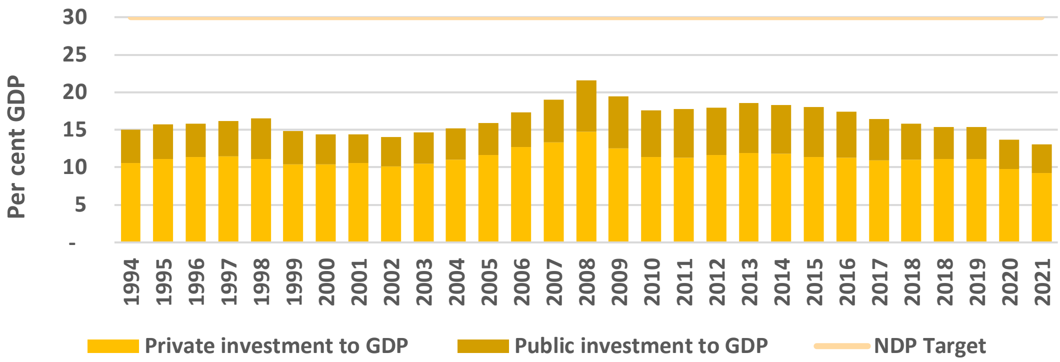

Figure 1: Investment to GDP ratio
(Source: South African Reserve Bank)

Barriers to infrastructure delivery emanate from the investment and financing, project preparation and implementation, and construction sides. Infrastructure projects are often poorly delivered owing to insufficient capacity to plan, implement and monitor infrastructure projects, an inability to raise the required finance to implement the project, project overruns, and the exclusion of project lifecycle costs in the budgeting process. The tendering process is long and onerous, characterised by delays in awarding tenders, and when awards are made, the lowest cost submission often takes preference over the quality and scope of tenders. Of increasing concern is the rise in mafia-like behaviour on construction sites which is hampering the delivery of projects and affecting investor sentiment, as well as threatening the safety of construction workers.

Following the COVID-19 pandemic, infrastructure investment was again highlighted in the NIP 2050 as a means to extricate the economy from a recession and reverse the growing unemployment issue. However, owing to the above-mentioned challenges, this has been slow in materialising. Furthermore, the fiscus is constrained and the scarce financial resources have to be carefully allocated.

RESEARCH METHODOLOGY

This study aims to examine empirically the potential impact on GDP and employment in South Africa of the remaining infrastructure investment allocation from the R100 billion Infrastructure Fund. The impact is assessed across various sectors to motivate for infrastructure investment into projects within sectors where the greatest impact will be achieved. This is explored through scenario-based analysis using the Energy-Environment-Economy Macro-Econometric Model (E3ME) developed by the European Commission's research framework and Cambridge Econometrics.

3.1. Background to the E3ME model

This widely used dynamic, structural, global macroeconomic model is well suited for analysing the impacts of Energy-Environment-Economy (E3) policies by allowing two-way linkages among the energy system, environment, and economy. This allows for the analysis of interactions among these components, as well as an investigation into the short-term dynamics and longer-term impacts of policies. The E3ME model manual provides a detailed description of the model, data sources and inputs, software, econometric specifications and modelling approaches. Table 1 provides a list of data sources used within the model.

Table 1: E3ME model data sources and key equations

Variable(s)	Data source	
	Historical data	Baseline forecast
Population	UN	IMF WEO (short-term) IEA WEO CPS (medium-term) IIASA SSP2 (long-term)
National accounts data	UN	
Labour force and employment	ILO	
Bilateral trade	OECD STAN	
Energy demand	IEA	IEA WEO CPS
CO2 emissions	EDGAR	

Equations sets:
Below are some of the equations of interest obtained from the Cambridge Econometrics manual (2019). For the full set of equations and additional details, please refer to the Cambridge Econometrics manual (2019). There are 61 countries or regions included in the model. The data is disaggregated to 69 economic sectors for European countries and 43 sectors for other countries, including South Africa.

Output equation
Co-integrating long-term equation:
LN(YRN) = BYRN + BYRN * LN(YRY) + BYRN * LN(YRX) + BYRN * LN(YKNO) + BYRN * LN(YCAP) + ECM
Dynamic equation:
DLN(YRN) = BYRN + BYRN* DLN(YRY) + BYRN * DLN(YRX) +BYRN * DLN(YKNO) +
BYRN * DLN(YCAP) + BYRN * DLN(YR)(-1) + BYRN * ECM(-1)

BYRN	matrix of parameters
YRN	matrix of normal industrial output for 69/43 sectors and 61 regions
YR	matrix of gross industry output for 69/43 industries and 61 regions
YRY	matrix of average industrial output (excluding own sector) for 69/43 sectors and 61 regions
YRX	matrix of average industrial output (excluding own region) for 69/43 sectors and 61 regions
YKNO	matrix of the knowledge stock for 69/43 industries and 61 regions
YCAP	matrix of the capital stock for 69/43 industries and 61 regions

Investment equation
Co-integrating long-term equation:
LN(KR) = BKR +BKR * LN(YR) + BKR * LN(PKR/PYR) + BKR * LN(YRWC) + BKR * LN(PQRM) + ECM
Dynamic equation:
DLN(KR) = BKR + BKR * DLN(YR) + BKR * DLN(PKR/PYR) + BKR*DLN(YRWC) + BKR * DLN(PQRM) + BKR * LN(RRLR) + BKR * LN(YYN) + BKR * DLN(KR)(-1) + BKR * ECM(-1)

Identities:
YRWC = (YRLC/PYR) / YREE
RRLR = 1 + (RLR – DLN(PRSC)) / 100

BKR	matrix of parameters
KR	matrix of investment expenditure for 69/43 industries and 61 regions
YR	matrix of gross industry output for 69/43 industries and 61 regions
PYR	matrix of industry output price for 69/43 industries and 61 regions
PKR	matrix of industry investment price for 69/43 industries and 61 regions
PQRM	matrix of import prices for 69/43 industries and 61 regions
PRSC	vector of consumer price deflator for 61 regions
YRLC	matrix of wage costs (including social security contributions) for 69/43 industries and 61 regions, local currency at current prices
YREE	matrix of employees for 69/43 industries and 61 regions
RLR	is a vector of long-run nominal interest rates for 61 regions
YYN	is a matrix of the ratio of gross output to normal output, for 69/43 industries and 61 regions

Employment equation
Co-integrating long-term equation:
LN(YRE)= BYRE + BYRE * LN(YR) + BYRE * LN(LYLC) + BYRE * LN(YRH) + BYRE * LN(PQRM) + BYRE * LN(YKNO) + BYRE * LN(YCAP) + ECM
Dynamic equation:
DLN(YRE) = BYRE + BYRE * DLN(YR) + BYRE * DLN(LYLC) + BYRE * DLN(YRH) + BYRE * DLN(PQRM) + BYRE * DLN(YKNO) + BYRE * DLN(YCAP) + BYRE * DLN(YRE)(-1) + BYRE * ECM(-1)
Identity:
LYLC = (YRLC/PYR) / YREE

BYRE	is a matrix of parameters
YRE	matrix of total employment for 69/43 industries and 61 regions
YR	matrix of gross industry output for 69/43 industries and 61 regions
YRH	matrix of average hours worked per week for 69/43 industries and 61 regions
YRLC	matrix of employer labour costs (wages plus imputed social security contributions) for 69/43 industries and 61 regions
YKNO	matrix of the knowledge stock for 69/43 industries and 61 regions
YCAP	matrix of the capital stock for 69/43 industries and 61 regions
PYR	matrix of industry output prices for 69/43 industries and 61 regions
YREE	is a matrix of wage and salary earners for 61 regions
PQRM	is a matrix of import prices for 69/43 industries and 61 regions

Source: Cambridge Econometrics E3ME Manual (2019)

The E3ME model includes both accounting and behavioural relationships, and is based on the national accounting framework, disaggregated to 43 industries. The model includes 29 stochastic equations encapsulating behavioural relationships which are set by employing cointegration and error-correction methodologies. Of specific importance to this paper is the E3ME's economic module, which accounts for changes in economic activity by persons, households, firms and other groups in society. Unless there are constraints to supply, output and employment are determined in the model by levels of demand. Cambridge Econometrics, in the E3M3 Technical Manual (2019), outlines the loops through which changes in the economy are transmitted through markets:

1. Sector interdependency loop: This loop captures the impact that a change in one sector will have on other sectors. An increase in output from one sector requires an increase in input which may be drawn from suppliers in another sector. This is similar to a Type I multiplier where intermediate demand is determined by the input-output relationships in the model.
2. Income loop: This loop captures the increase in labour demand as a sector increases its output and grows. As more people are employed, incomes increase and consumption expenditure with it, which in turn increases total demand and feeds back into the economy, which is similar to a Type II multiplier.
3. Investment loop: As firms and the demand for the goods or services that they supply increase, they invest in expanding their production capacity. Production investments increase the demand in sectors that produce investment goods (e.g., construction, engineering) and their supply chains.
4. Trade loop: Imported goods and services are necessary when the uptick in domestic demand cannot be met by domestic supply. The model allows for interactions among different countries and captures the impact on a country when there is an increase in demand for imported goods from another country.

For illustrative purposes, Figure 2 captures the interdependencies among these loops.

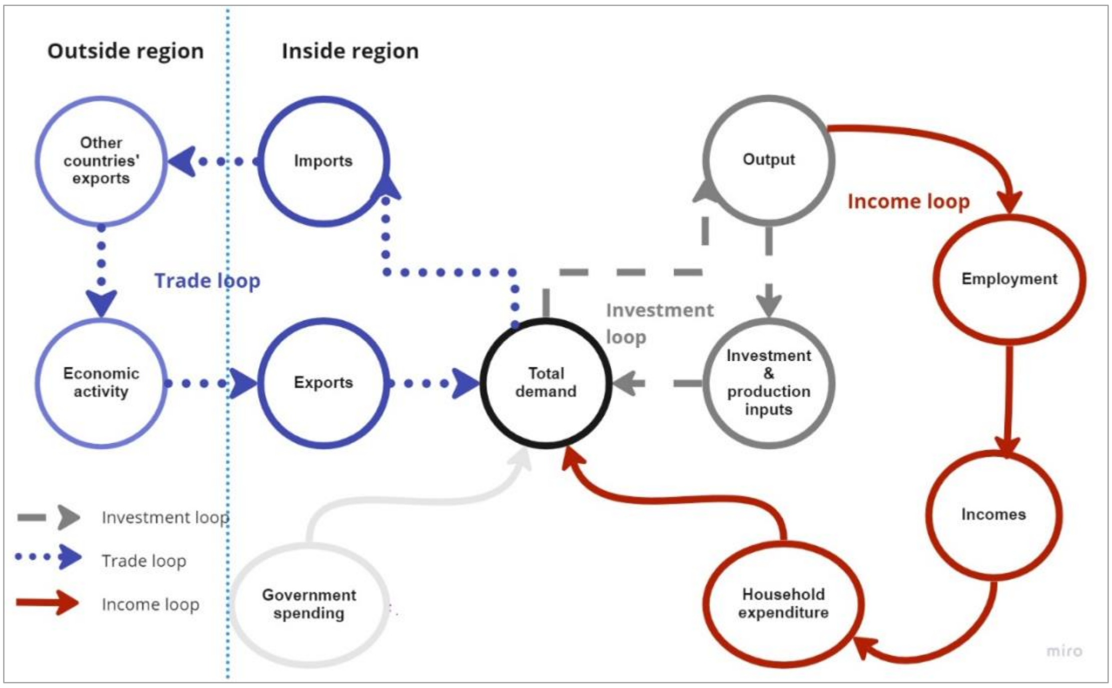

Figure 2: A diagram illustrating E3ME's economic structure
Source: Cambridge Econometrics E3ME manual (2019)

The main differences between E3ME and Computable General Equilibrium (CGE) models are the assumptions about optimisation. While CGE models generally determine behavioural factors through an optimising framework, E3ME determines behavioural factors empirically (Cambridge Econometrics, 2019).

3.2. Modelling Infrastructure Investment

The E3ME model generates a baseline using the behavioural and accounting relationships of the model and the country-specific databases from which it draws. Exogenous shocks can then be imposed on the model to determine the impact of the shock, measured as the deviation from the baseline. The imposition of shocks allows for scenario-testing, which enables evidence-based decision making premised on which scenario leads to better economic and social outcomes.

This paper uses the investment allocated towards the Infrastructure Fund as an exogenous shock to the model. Since the Infrastructure Fund is not captured in any departmental budgets, it is not included in the baseline of the model and is therefore an ideal example of an exogenous investment shock. Any exogenous changes in investment – recorded as gross fixed capital formation – are captured in the Exogenous Investment Expenditure variable (KRX). Gross fixed capital formation (investment) consists of machinery and other equipment, transport equipment, construction works, buildings and other assets. The investment period begins in 2023 and extends to 2028, the remaining timeframe of the Infrastructure Fund. While the Infrastructure Fund is premised on catalysing private sector investment, this paper does not make assumptions on the magnitude of private sector investment that can be unlocked through the Infrastructure Fund.

Aligning with the priorities identified in the NDP and NIP 2050, the Infrastructure Fund focuses on investment into economic and social infrastructure, including amongst others electricity, water, transport, telecommunication, education, and health. Infrastructure development in these sectors is anticipated to open opportunities for growth. In keeping with the focus of the Infrastructure Fund and for the purpose of this paper, these abovementioned key sectors have been grouped into three categories. The weight of each sector in the respective categories is based on the current distribution of investment, based on the national accounts data. Category 1 includes electricity and water and is referred to as utilities infrastructure. Category 2 includes transport (land transport, air transport and water transport,) and telecommunications and is referred to as transport and telecoms infrastructure. Category 3 includes health, social work and education and is referred to as social infrastructure.

To determine the impact of the Infrastructure Fund investments on economic growth and employment, three scenarios with varying levels of investment are modelled. The three scenarios are captured as follows:

1. Scenario 1 assumes the bulk of the investment (50 per cent) is channelled towards **utilities infrastructure** (electricity and water in a 90:10 ratio) and the remainder is equally divided between transport and telecoms and social infrastructure. Figure 3 depicts the allocation of exogenous investment under Scenario 1.

2. Scenario 2 assumes the bulk of the investment (50 per cent) is channelled to **transport and telecoms infrastructure** (land transport, water transport, air transport and communications in a 50:10:10:30 ratio) and the remainder is equally divided between utilities and social infrastructure. Figure 3.1 depicts distribution of investment into economic and social infrastructure under Scenario 2.

3. Scenario 3 assumes the bulk of the investment (50 per cent) is channelled to **social infrastructure** (health and social work, and education in a 90:10 ratio) and the remainder is equally divided between utilities, and transport and telecoms infrastructure. Figure 3.2 demonstrates the distribution of investment into economic and social infrastructure under Scenario 3.

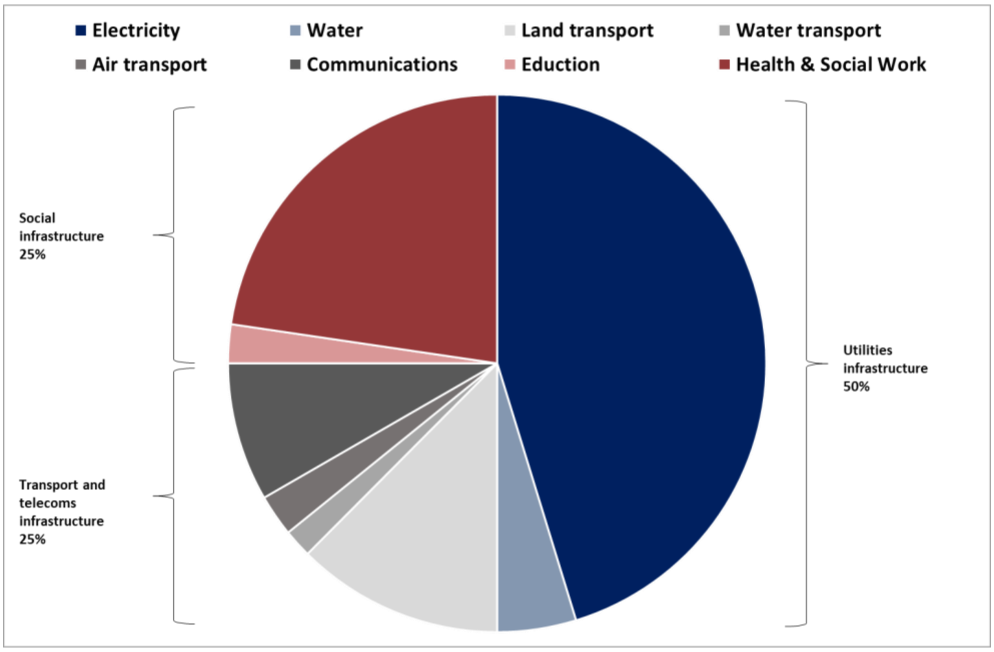

Figure 3: An illustrative graph of the distribution of investment into economic and social infrastructure under Scenario 1.
Source: Authors' assumptions

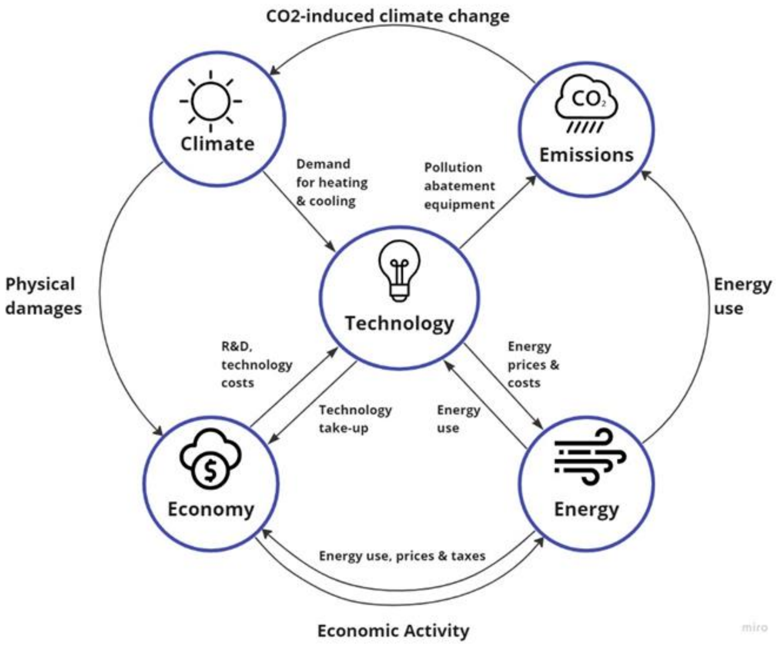

Figure 3A1:
The feedback mechanism between the Energy, Environment and Economy model components
Source: Cambridge Econometrics E3ME Manual (2019)

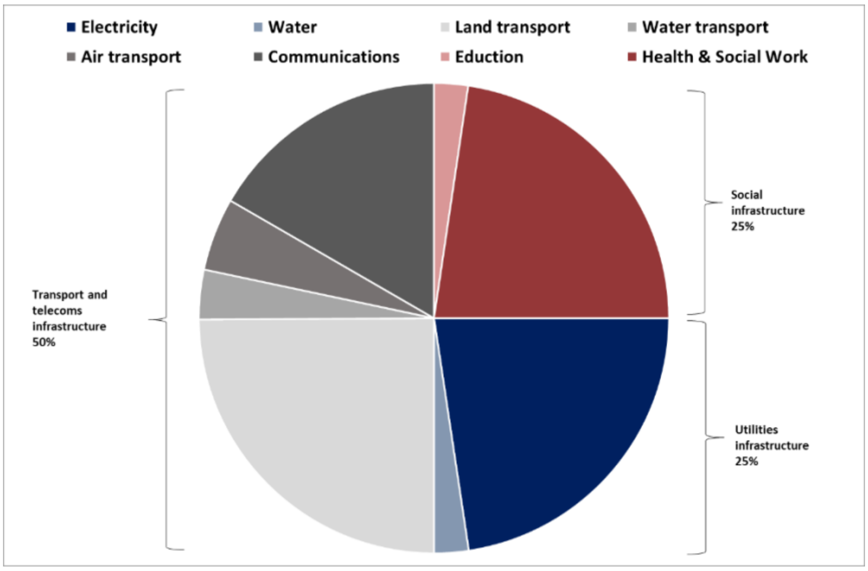

Figure 3.1: An illustrative graph of the distribution of investment into economic and social infrastructure under Scenario 2
Source: Authors' assumptions

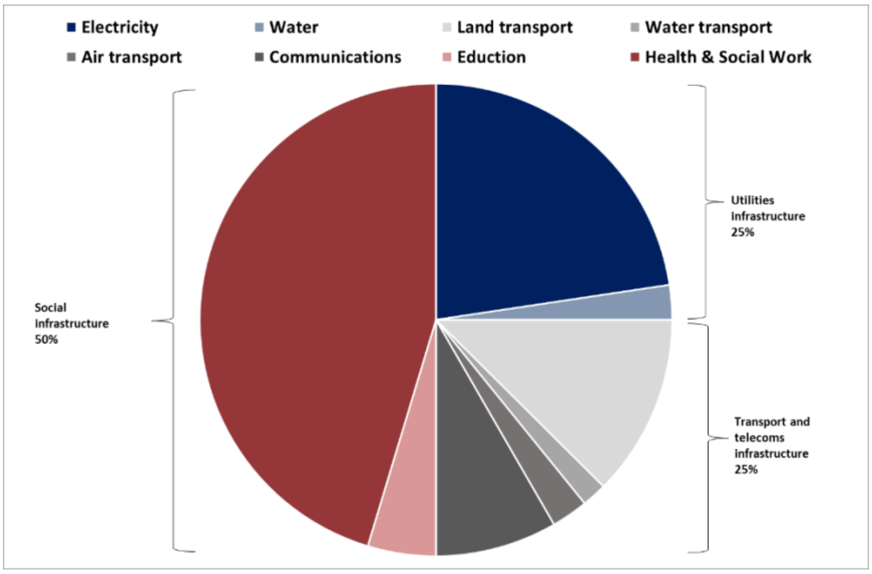

Figure 3.2: An illustrative graph of the distribution of investment into economic and social infrastructure under Scenario 3
Source: Authors' assumptions

The current scenario formulation is not informed by historical BFI allocations owing to limitations in the existence of a strong pipeline to inform trends in the types of project investments, therefore limitations in informing future allocations. Secondly, the allocations are provided on the basis of project preparedness and do not speak to the dynamics of the economy at the time or what the optimal outcome from a growth impact perspective is. Finally, the Infrastructure Fund does not have an expenditure or investment guide for different project categories, and specificity in assumptions can only be informed by such a guide. The infancy of the Infrastructure Fund implies the analysis needs to assess the full and dynamic potential of the programme.

Guided by information published in the Budget Review 2023, this paper makes the following assumptions about the distribution of the remaining R97 billion: R7.2 billion in 2023, R14.7 billion in 2024, R16 billion in 2025, R18 billion in 2026, R20 billion in 2027 and R21 billion in 2028. The allocations from the Infrastructure Fund for the first two years (2023-2024) are based on information provided in the Budget Review 2023. The assumptions made from 2025 onwards are based on the authors' own assumptions for the purpose of this paper and are in no way a commitment made by the National Treasury. The authors assume that the allocations will increase incrementally until 2028

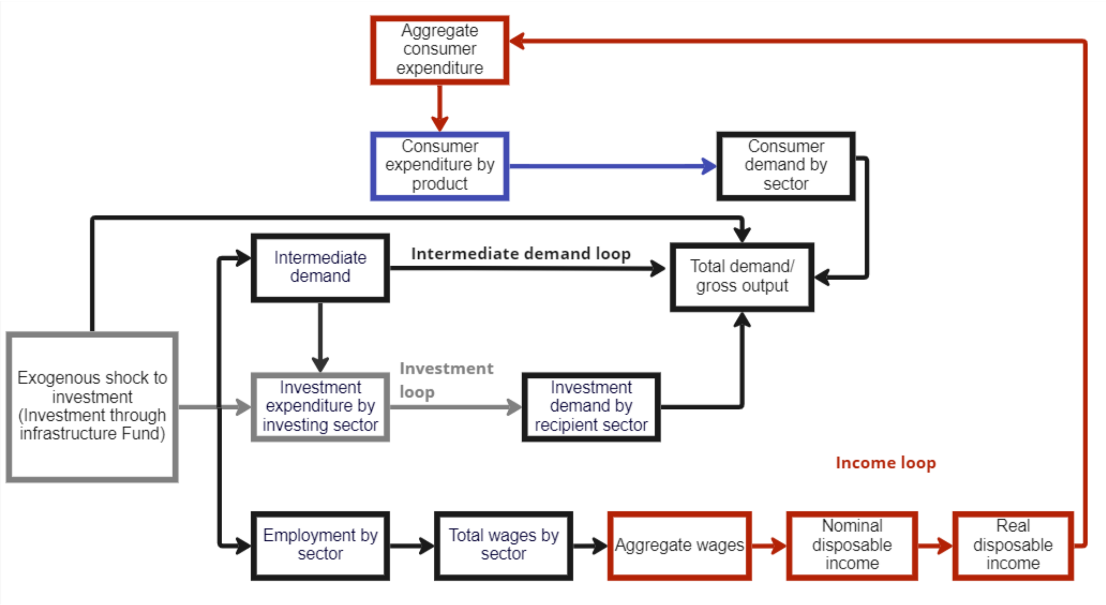

Figure 4: A diagram illustrating an exogenous investment shock's feedthrough mechanisms in the E3ME model. Source: Cambridge Econometrics E3ME manual (2019)

Figure 4 illustrates how an exogenous investment shock is expected to feed through the interdependent loops within the economic model of the E3ME model. Exogenous infrastructure investment initially impacts the investment loop, before feeding into the intermediate demand and income loops.

DATA ANALYSIS

It should be noted that the projections and simulation results presented are quantified estimates of the relative impact of the investment fund on the various indicators and should not be interpreted as predictions. As such, the generally accepted method of reporting the impact of the policy change on economic, social, and environmental indicators is to report the difference from the baseline (Cambridge Econometrics,

2019). In theory, one can expect that the impacts of infrastructure investment would be felt on both the demand side (a near-term stimulus effect) and the supply side (in the long run, from an increase in economic capacity, and a potential reduction in unit costs). As a demand-driven model, E3ME is mainly suited to analyse the first of these. Therefore, these results likely underestimate the long-run benefits of this investment spending, as the model does not capture the potential supply-side impacts.
The E3ME model captures not only the direct and indirect impacts of stimulus spending at a point in time, but also short-run business cycle dynamics over time. These short-run effects are a function of the lagged differences of explanatory variables, in other words, the direction of travel of the economy, and capture economic frictions and the economic agents. In this case, the removal of the investment subsidy inevitably produces a year-on-year reduction in output, which influences the expectations of consumers, who (at the margin) make more conservative spending decisions. This produces a slightly negative macroeconomic outcome relative to the baseline in 2029. However, the overall negative impact is minimal, and it is more accurate to describe the results as reverting to the baseline trend.

4.1. Aggregate Results

From the results, it can be inferred that an external shock of almost R100 billion from the Infrastructure Fund to investment in utilities, social or telecoms and transport infrastructure results in a small but permanent improvement in aggregate economic activity relative to the baseline, as illustrated in Figure 5. By 2028, GDP is expected to be 0.3 per cent higher compared with the baseline as a result of the R97 billion investment. The results further show that the largest impact on economic activity is reported under Scenario 1, where the bulk of investment is in utilities. It should be noted, however, that the impact on growth from the three scenarios all yield fairly similar results in terms of the magnitude of impact, and a greater shock to investment is thus needed to determine whether the impact from the various scenarios differs significantly.

The pass-through effect of the exogenous infrastructure shock is most pronounced in the investment loop. This is seen by the large uptick in investment expenditure by the investing sector and investment demand by the recipient sector. The effect in the intermediate demand loop is less pronounced; however it does move as expected owing to the increased demand for inputs by investment-implementing sectors such as the construction sector. By 2028, investment expenditure will have increased by 2.0 per cent from the baseline, while total demand increases by 0.2 per cent from the baseline when the bulk of investment is made towards utilities. Over the long term, economic activity tends to the baseline; however, it does indicate a small, positive impact on economic growth.

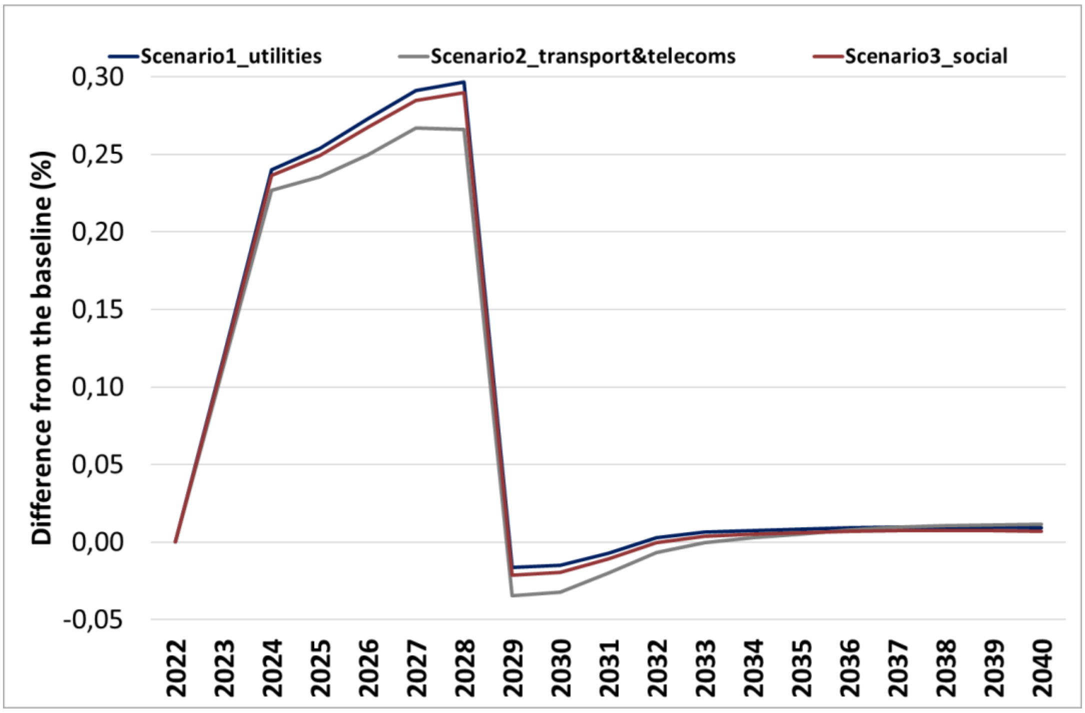

Figure 5: Aggregate GDP
Source: Authors' own results from the modelling excercise

Figure 6 illustrates that the increase in investment has a positive impact on employment. Employment increases and peaks at 0.06 per cent above the baseline by 2028. Specifically, the uptick in employment is most pronounced when the largest share of investment is allocated towards utilities, followed by investment into social infrastructure. The impact on employment captures the income loop, and Figure 6 highlights the lagged effect that investment has on wages and consumer expenditure. Infrastructure investment will increase employment as labour will first be required to construct this infrastructure and second, to increase output by material suppliers. The increase in labour demand for construction activities will be the first-round effect, while the expansion of production capacity may be lagged as it is a second-round effect.

Moreover, investment into production capacity is not limited to labour but also encompasses production machinery and equipment, thus making the second-round effect into production capacity less impactful. In line with the findings from Mbanda and Chitiga-Mabugu (2016), the results indicate that infrastructure investment will generate more jobs in absolute terms in highly- and semi-skilled occupations. In line with the classifications by Stats SA in the Standard Classification of Occupations, highly-skilled occupations include managers, professionals and technicians and associate professionals; semi-skilled occupations include clerical support workers, services and sales workers, skilled agricultural and fishery workers, craft and related trades, and plant and machinery operators and assemblers; while low-skilled occupations cover elementary occupations. In anticipation of this, the infrastructure investment drive should be accompanied by measures that increase the skills of the existing labour force so that these employment opportunities can be utilised. South Africa has an overwhelming number of unskilled labourers who, with some training, would be better positioned to benefit from infrastructure investment.

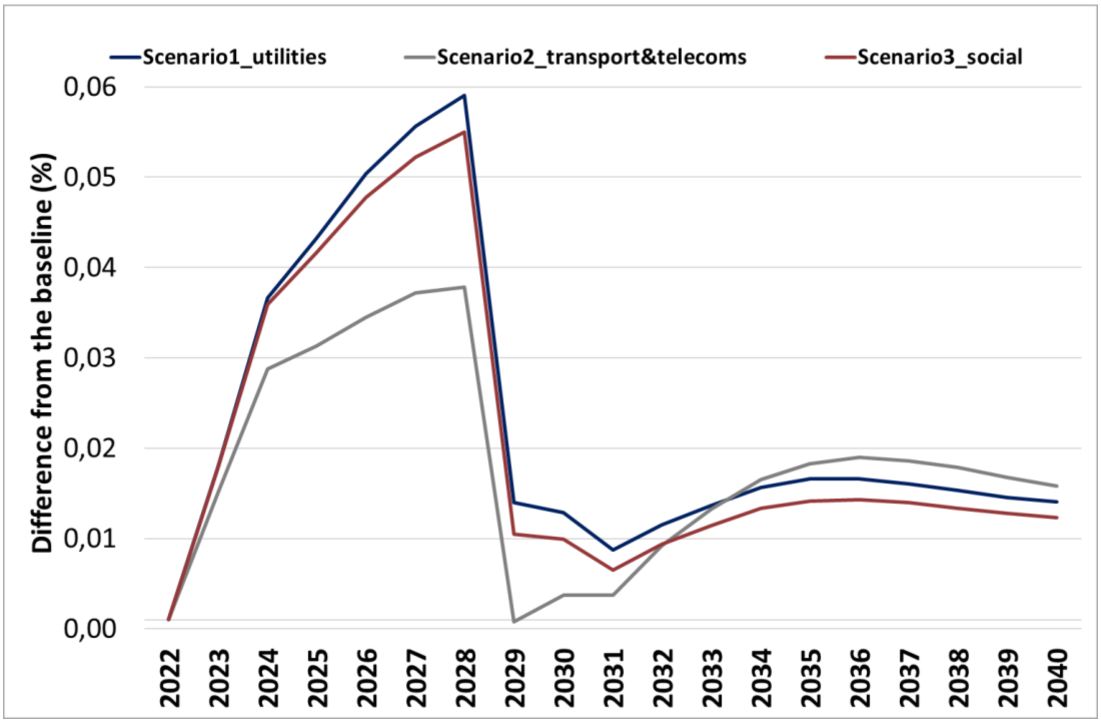

Figure 6: Aggregate employment
Source: Authors' own results from the modelling exercise

The aggregate results indicate that the impact on both growth and employment is the most significant in the secondary sector, followed by the primary sector and lastly, the tertiary sector. The modelling results are available for all 43 industries, although for the purposes of this paper, industries have been grouped according to primary, secondary and tertiary sectors and include an explanation of which industries are driving the results. This is discussed more broadly below.

4.2. Primary Sector

The results in the primary sector follow a similar pattern to the aggregate results. Figure 7 illustrates that by 2028, primary sector GVA is expected to be approximately 0.3 per cent higher compared with the baseline as a result of the R97 billion investment in economic and social infrastructure. The results are driven by the mining sector and are predominantly due to an increase in demand for intermediate inputs from the sector, or the Type I multiplier. The mining sector has strong forward linkages to the construction and other transport equipment sectors; therefore, the construction of economic and social infrastructure will increase the demand for intermediate inputs supplied by the mining sector. The infrastructure investment is also expected to have a positive, albeit marginal, impact on employment in the primary sector, driven again by the mining sector as illustrated in Figure 8. By 2028, primary sector employment is expected to be around 0.05 per cent higher compared with the baseline as a result of the investment. Increased investment in infrastructure and additional intermediate inputs required to construct infrastructure also result in increased labour demand and higher levels of employment in the mining sector.

Scenario 1, where the bulk of the funds are allocated to utilities; and Scenario 2, where the focus of the investment is social infrastructure, yield the greatest impact. ArcelorMittal indicates that each new megawatt (MW) of solar power requires between 35 to 45 tons of steel, and each new MW of wind power requires 120 to 180 tons of steel with iron ore and scrap metal being the main inputs to steel. Renewable energy sources such as solar photovoltaic (PV), wind and batteries as well as power cables in distribution and transmission networks also use a wide range of materials such as copper, manganese, nickel, chrome, and aluminium, all sourced from the mining sector. Furthermore, economic and social infrastructure construction activities require other building materials such as cement and bricks with raw materials such as limestone also sourced from the mining sector.

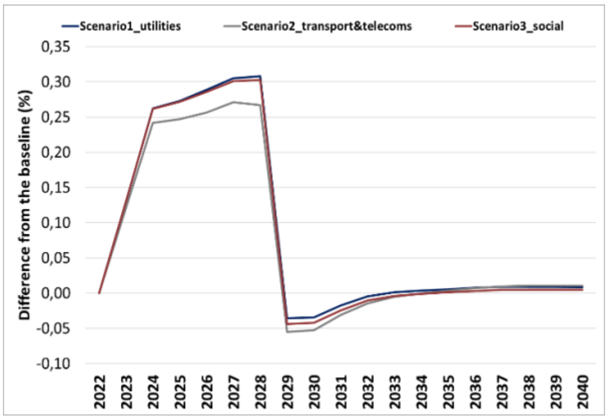

Figure 7: Primary sector GVA

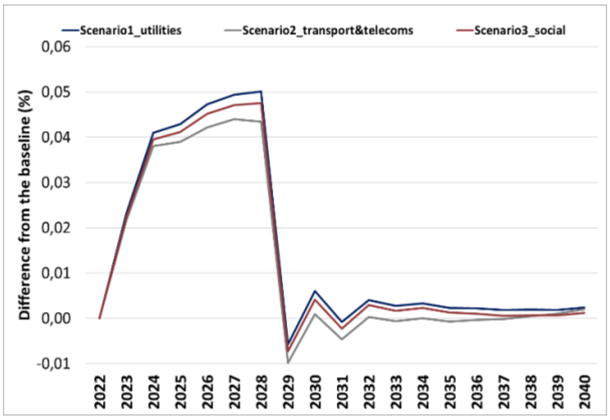

Figure 8: Primary sector employment

Source: Authors' own results from the modelling exercise

4.3. Secondary Sector

Relative to the primary and tertiary sectors, the investment impact is the greatest in the secondary sector. By 2028, economic growth in the secondary sector is anticipated to be 0.6 per cent higher than the baseline when there is an increase in infrastructure investment. Employment is expected to increase by approximately 0.15 per cent by 2028, with employment growth remaining positive over the long term. The drivers of the uptick stem from an increase in demand for construction services as well as an increase in the demand for manufactured intermediate goods, both of which contribute directly to enabling infrastructure delivery. While the investment into infrastructure such as electricity and water will allow for expansion in the manufacturing sector due to the availability of inputs into the production of goods, this supply side effect is not well captured in the model. Rather, the model captures the effect of an increase in demand for the goods or services produced by the secondary sector when there is an increase in investment.

The employment figures do not reflect the same movements as the growth graph owing to the differing employment patterns of the two driver sectors. The construction sector, from which the majority of the increase in employment stems, increases employment rapidly in the initial years of investment and in line with infrastructure expenditure. Once the project implementation period is complete, employment in the sector returns to the baseline. In contrast, the expansion in manufacturing employment increases steadily from 2023, and drops off once the investment period is complete, but does not return to the baseline. This steady increase reflects an expansion in manufacturing capacity, which takes time and is less labour intensive. An increase in demand for manufactured goods will first be met by an increase in production with available manufacturing capacity, then through inventories, and then through expanded capacity. Where technically and economically feasible, the expanded capacity may also decrease the demand for imported manufactured goods and shift towards locally-produced intermediate goods.

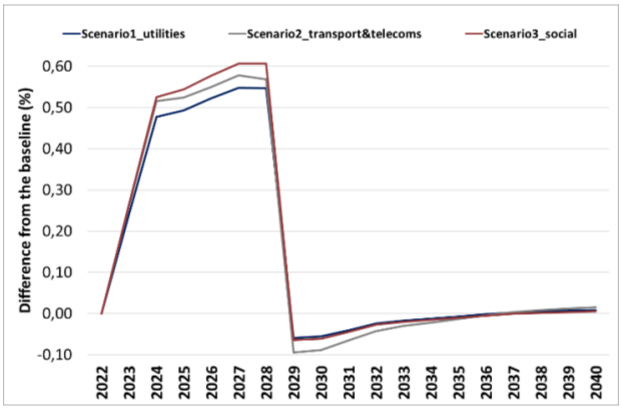

Figure 10: Secondary sector GVA

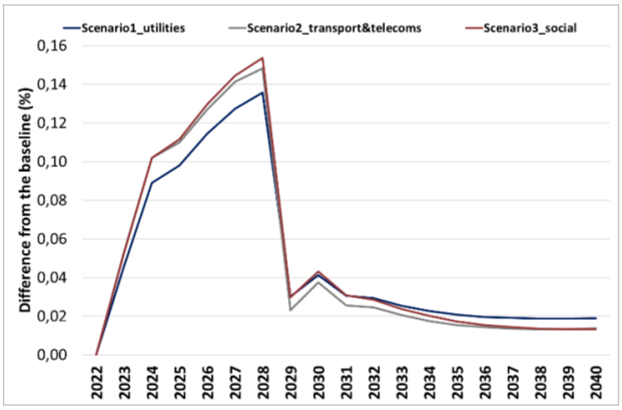

Figure 9: Secondary sector employment

Source: Authors' own results from the modelling exercise

In terms of manufacturing, manufactured intermediate goods such as steel, cement and bricks, tar, glass and the like are primary inputs into most infrastructure projects. Manufacturers of such products benefit from the uptick in demand for construction materials, thus enabling them to expand their outputs and operational capacity, and increase employment. According to the World Bank Group (2022), as of 2021, South Africa imported approximately 64 per cent of its manufactured goods. While infrastructure investment has a significant impact on the domestic manufacturing sector, this impact could in fact be even larger if the investment drive was accompanied by measures that prioritised the use of domestically manufactured goods through support for the expansion of the production of value-add manufactured goods.

Intermediate goods produced by the manufacturing sector are then utilised by the construction sector for the implementation of infrastructure projects. The construction sector, which benefits the most from the increase in infrastructure investment, is labour intensive and provides employment opportunities for individuals of various skill levels ranging from low to highly-skilled labourers. The demand for services provided by the construction sector increases with infrastructure investment, and it is thus the sector that drives the aggregate increase in employment. This reinforces the drive by the South African government to utilise infrastructure investment as a stimulus for employment in the country.

The greatest growth in both gross value-add and employment is achieved when the bulk of the investment is made towards social infrastructure (Scenario 1), followed by the bulk of investment being channelled towards transport and telecoms infrastructure (Scenario 2). The construction of social infrastructure is more labour and material intensive than the construction of utilities and telecommunications and transport infrastructure. This is consistent with results found by Heintz and Peltier (2009), who examined investment into different infrastructures in the USA. A USD 1 billion investment into school infrastructure provided 14 029 direct employment opportunities, whereas an investment of the same magnitude into transport generated 13 829 direct employment opportunities, while water and electricity generated an average of 13 024 direct employment opportunities.

Tertiary Sector

Tertiary sector output and employment results are also positive, in line with the aggregate findings. Output is expected to increase by 0.25 per cent by 2028 (Figure 11). In the long run, the impact is negligible and just above 0.0 per cent. In terms of employment, Figure 12 shows that a marginal increase of 0.04 percentage points above the baseline is expected by 2028. Further contributions are expected in the long run, with the employment contribution peaking at just above 0.02 per cent above the baseline in 2036.

Despite the positive results, the investment impact on the tertiary sector is the smallest relative to the secondary sector, followed by the primary sector. This speaks to the nature of how, as discussed above, infrastructure spending is expected to support input-intensive sectors as well as the construction sector more directly. The positive tertiary sector results are driven by engineering services, transport and telecommunications sub-sectors. Engineering and transport are seen as support functions for economic activity in other sectors and will therefore benefit from infrastructure investments. Engineering services provide engineering design services, which include project management activities related to construction and water management projects (Statistics South Africa, 2012). These services differ from the civil engineering works under the construction sector, which captures the actual construction of civil engineering projects. These are considered to be heavy construction projects such as streets, bridges, railways, harbours and other water projects, and electricity facilities. These services are expected to support the development of the infrastructure projects under the various scenarios.

According to Bezuidenhout et al. (2008), the disproportionate distribution of raw materials, labour, factories and markets necessitates the utilisation of transport to support economic activity. This highlights the role that the transport sector will play in moving goods and labour, both for the primary and secondary sectors. With respect to telecommunication services, Beyh and Kagioglou (2004) found that communication means are necessary for mobile personnel on the construction site, which, through the advancement of technology, have evolved to offering services, including collection and management of data. This is an additional service that is expected to grow from construction-related investments as companies seek to optimise project development.

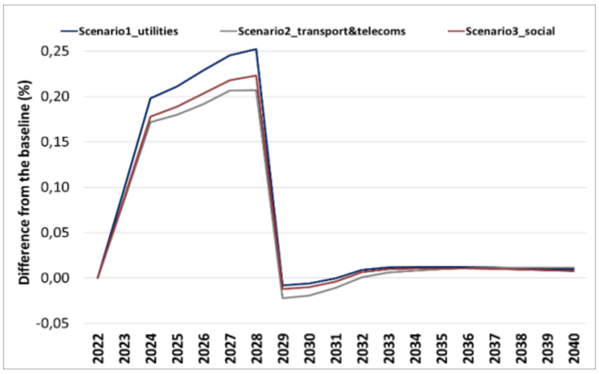

Figure 12: Tertiary sector GVA

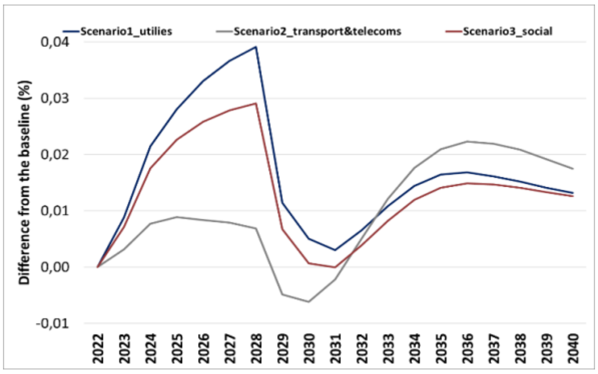

Figure 11: Tertiary sector employment

Source: Authors' own results from the modelling exercise

Directing the largest share of investment in infrastructure to utilities (Scenario 1) results in the greatest impact on output. The development of energy infrastructure projects for the generation, distribution and/or transmission of power and water projects such as wastewater treatment facilities is expected to trigger the support functions within the tertiary sector. This may be driven by South Africa's need to import more of its wind and solar PV characteristic products such as gearboxes, blades, towers, solar panels, and converters, expected to provide additional support for transport services (Rivett-Carnac, 2022a and 2022b). For instance, under the fourth round of the Renewable Energy Independent Power Producer Procurement programme, transport costs for wind farms were 13 per cent of total project costs (Rivett-Carnac, 2022b). This indicates the significant role of both costlier and specialised transportation of large components (such as masts and blades) and its need over longer periods during the development phase. Rivett-Carnac (2022b) indicates that for the Jeffreys Bay Wind Farm that started commercial operations in July 2014, transportation of the wind turbines from the Port of Ngqura to the project site started in July 2013 and was completed in February 2014. This covered a total distance of 110 000 kms. Similarly, the greatest employment impact is driven by the utilities infrastructure investment (Scenario 1), which is expected to follow output results. However, in the long run, the peak in employment contribution of a marginal 0.02 per cent above the baseline is driven by Scenario 2 results, where the greatest share of investments is in transport and communications.

DISCUSSION OF FINDINGS

Based on the findings from this paper, the following can be concluded in terms of policy implications:

1. Infrastructure investment can stimulate both economic growth and employment creation. Despite the magnitude of investment modelled in this paper being small relative to total investment, the results still indicate the positive effect of infrastructure investment. This paper therefore supports the existing body of research that indicates that infrastructure investment can stimulate economic growth and increased employment, and confirms that the results hold in the South African context. The impact is expected to be the greatest in the secondary sector, driven by construction and manufacturing.
2. Infrastructure investment can be targeted at a sectoral level: A study such as this can contribute to policy discussions surrounding targeted investment expenditure which aims to prioritise employment and/or economic growth. Specifically, it can provide empirical support for a sectoral approach to infrastructure investment. This is in line with the recommendation that suggests that projects in the electricity and water sector receive the bulk of infrastructure investment, given that investment into these sectors yields the greatest impact on overall economic growth and employment creation. With reference to the Infrastructure Fund, this study motivates for investment into capacity building for submitting entities and project sponsors in specific sectors, such as water and electricity, wishing to submit projects for funding through the Infrastructure Fund. Improved capacity will increase the number of well-prepared projects with sound financial models within sectors that yield the greatest impact on economic growth and employment.
3. Measures targeting skills improvements should be taken in expectation of the infrastructure investment programme. Given that infrastructure investment will generate the greatest number of employment opportunities for semi- and highly-skilled individuals, it is suggested that measures that will improve the skills distribution of South Africans be explored. Skills development relevant to sectors such as construction and manufacturing will be most needed with increased infrastructure investment.
4. The production of value-added manufactured goods should be expanded to meet the additional demand for intermediate goods. South Africa is still dependent on imports for many manufactured goods; however, an opportunity exists to expand the production of intermediate goods utilised in the construction process. This will enable more locally manufactured goods to be used in the construction of large-scale infrastructure projects funded through the Infrastructure Fund. There are opportunities to develop local industries, including introducing additional certification and testing of products to comply with international standards; supporting the production of correct product specifications; continuity and certainty in investment opportunities to enable the development of industries; and concessional finance to support the growth of small manufacturers (Rivett-Carnac, 2022a and 2022b). Pre-emptive action can be taken to explore measures such as combining taxes and incentives to

make domestically produced manufactured goods more competitive relative to imported goods.

CONCLUSION

The study modelled the impact of the remaining investment commitment of R100 billion under the Infrastructure Fund. The investment shock is applied to the exogenous investment variable of the E3ME model under three scenarios. Scenario 1, which assumes the bulk of the investment is allocated to utilities infrastructure; Scenario 2 which assumes the bulk of the investment is directed to transport and telecoms infrastructure; and Scenario 3 which allocates the bulk of the investment to social infrastructure. In line with the literature, the study finds that on aggregate, there is a positive impact on growth and employment when investing in economic and social infrastructure. By 2028, GDP is expected to be 0.3 per cent higher compared with the baseline while employment increases and peaks at 0.06 per cent above the baseline by 2028. These results are attained under Scenario 1, where the bulk of investment is in utilities. The results under the three scenarios do, however, yield similar outcomes in terms of the magnitude of impact, and a greater shock to investment is needed to determine the extent to which the scenarios differ significantly.

In terms of the sectoral results, primary sector output is expected to be approximately 0.3 per cent higher in 2028, compared with the baseline. By 2028, primary sector employment is expected to be around 0.05 per cent higher compared with the baseline as a result of the investment. These results are attained under Scenario 1, where a large investment in utilities is expected to support the mining sector through its close link to primary inputs required for construction and transport material. Secondary sector GDP is expected to be 0.6 per cent higher than the baseline by 2028, while employment is expected to increase by approximately 0.15 per cent by 2028. These results are expected under Scenario 3, with increased investment allocated to social infrastructure. Investments will support the construction and manufacturing sectors, both of which contribute directly to enabling infrastructure delivery. In the tertiary sector, output is expected to increase by 0.25 per cent above the baseline. Employment is expected to increase by 0.04 percentage points above the 2028 baseline. Tertiary sector results are supported by the scenario where the greatest investment is directed to utilities infrastructure, which is expected to trigger engineering services, transportation and telecommunications support functions within the tertiary sector.

The results of the study not only highlight the extent of the positive gains government can expect from the implementation of the Infrastructure Fund investments, but also highlight the sectoral impact behind the results. This can enhance policy planning, allowing governments to, a priori, establish the types of investments that will have the greatest impact.

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DISCLAIMER

The views expressed in this paper are the personal views of the authors and do not represent those of the National Treasury. While every precaution is taken to ensure the accuracy of information, the National Treasury shall not be liable to any person for inaccurate information, omissions or opinions contained herein.

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