Analysing job creation effects of scaling up infrastructure spending in South Africa

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ABSTRACT

In a first for South Africa, this article raws on literature on infrastructure productivity to model dynamic economy-wide employment impacts of infrastructure investment funded with different fiscal tools. Using a dynamic computable general equilibrium model, the South African investment plan is modelled, given the infrastructure externality. Alternative fiscal scenarios to finance the policy are modelled in the article. In the long run, unemployment decreases for all types of workers under one of the scenarios. In the short run, only elementary occupation workers benefit from a decrease in unemployment; for the rest, unemployment rises.

KEYWORDS
Fiscal policies; employment; dynamic computable general equilibrium model; infrastructure scale up; externalities; South Africa

JEL Classification D58; D92; H54; H59

1. Introduction

The literature on the causes of economic growth presents evidence that infrastructure and capital formation are important determinants of economic growth and rising per-capita incomes over time. This is a lesson that has been well learned and applied in Asian econ-omies over the last several decades where large public investments have contributed to high economic growth. According to Estache (2007), infrastructure seems to be returning to the agenda of development economists. In South Africa, investment in infrastructure in the years preceding democracy was in general very low. The country's fiscal choices since 1994 have contributed to positive gross domestic product (GDP) growth rates, improved welfare and standards of living, and access to bulk economic infrastructure by a majority of the population. The country has made remarkable progress in reducing poverty and inequality but still faces tremendous shortfalls in economic and social infrastructure. In response, the government has adopted a raft of measures. The National Development Plan (NDP) sets ambitious goals for social reforms to eliminate poverty and reduce inequality by 2030. To provide the necessary revenue to meet these goals, the economy needs to grow faster, by 5.4% per annum according to the NDP. Growth is affected by the long-standing structural weaknesses in the economy, as a result of long-term planning and financing challenges, and the lack of a strategic vision.

The NDP and the Infrastructure Development Act, which sets the framework for the Presidential Infrastruc-ture Coordinating Commission, provide a clear vision and policy basis from which to work. The main pillars of government economic policy, the New Growth Path, the Indus-trial Policy Action Plan and the Strategic Infrastructure Projects are anchored in a significant ramping up of current and capital expenditure by the state. In the 2014 Budget, the government allocated a total of R847 billion to public infrastructure investment, in par-ticular the transport and electricity sectors. Much is riding on state infrastructure spending being the solution to reducing poverty, inequality and unemployment and generating economic growth.[1]

The extensive infrastructure programme is aimed at rectifying inadequate and inefficient infrastructure, and improving and increasing the country's infrastructure network. This infrastructure drive is propelled by economic growth imperatives and broader social. In other words, the country faces a triple infrastructure challenge:

- to provide infrastructure that stimulates economic growth and job creation;
- to maintain existing infrastructure; and
- to provide infrastructure and services to the poor in order to eradicate poverty.

The idea of the government investing in public infrastructure, to support production and trade, and thus growth and development, is well established. The argument for public investment rests on the belief that resources allocated to investment translate into an equivalent value of public capital stock that, by lowering the cost of production or distribution, benefits the private sector and affects overall growth. In the post-war years (1950s and 1960s), the economic models underlying the five-year plans and industrialisation strategies relied heavily on high levels of public investment. However, South Africa has certain challenges that hinder the effective use of the resources for development. Given these weaknesses and the importance of public infrastructure for national development and regional performance, there is a pressing need to get public infrastructure right.

The question of whether there are economic gains from the provision of higher levels of public spending on capital is fundamental.2 If a higher level of capital raises the growth path of the economy, then it is justifiable on both equity and efficiency grounds. Whilst no one will argue about the equity issues involved, some will no doubt argue that additional public spending can create efficiency costs. There are a number of possible reasons for this. Firstly, whilst public capital is usually productive, this is by no means the consensus view empirically, and the literature contains a wide variety of estimates of the size of the marginal product of public capital ranging from positive to negative. Even if it is assumed that the marginal product of additional public spending is positive, critics might presumably ask further questions. First, is the effect of such spending perma-nent or temporary; and if temporary, of what magnitude and after what period of time can one expect positive effects? Government spending on public-sector capital may have posi-tive multiplier effects and may, therefore, raise economic activity and thus economic growth. However, once installed will these effects drop to zero? The answer

[1]In its drive to raise employment levels, the South African government has put in place a number of other policies/programmes such as the Expanded Public Works Programme and the Community Works Programme that also affect location and investment.

[2]For a detailed discussion of relevant papers in this field, see Aghion & Howit (2000).

here is not clear. In a Solow-type growth model the effects on growth would be expected to be tran-sitory, positive initially but zero in the new steady state with a higher level of output. But if public capital raises education and innovation, which might be expected in South Africa, the effects could be permanent and indeed much of the gains could come from spillover effects raising the productivity of private-sector capital and labour. Secondly, critics of public spending would presumably argue that even if public capital has a positive effect, its magnitude would need to be compared with the productivity of private-sector capital; if inefficient public capital spending is crowding out efficient private-sector capital, the effects on the economy could be negative. Thirdly, consideration would have to be given to how the public spending is financed. Raising taxes or borrowing could both have negative effects on economic activity which might offset the gains of public-sector capital spending.

This article reflects on the current state and likely future of South African infrastructure investment policy, focusing specifically on government infrastructure spending and how alternative financing arrangements will affect employment, both in the short term and the longer term. For these purposes, a recursive dynamic computable general equilibrium (CGE) model with elaborate labour market disaggregation, government budget constraints and alternative funding options for infrastructure scale up is used.

2. Literature review

(Neo)Classical economics generally assumes that activist fiscal policy is unnecessary to increase employment and production. Government expenditure is believed to be consumptive and leading to crowd out of private investment if financed with public debt. Wagner's law assumes that public expenditure is endogenous and hence cannot be used as a policy lever. Politicians at best should pursue balanced budget strategies. Keynesian economists, on the other hand, believe that public expenditure is important in determining the level of income as well as its distribution. The market mechanism would not be sufficient to restore full employment. There is a substantial body of empirical literature related to the public expenditure–economic growth nexus (see Moreno-Dodson [2009] for a review of government spending and economic growth studies). An important strand of the literature of direct relevance for this study is the idea that the composition of public expenditures (capital versus current) can have differential impacts on economic growth.

There is an extensive literature, both theoretical and empirical, on the effects of public capital spending on output dating back to Arrow & Kurz (1970) and Aschauer (1989). During the 1980s and 1990s, there was strong academic interest in the link between public investment in infrastructure and economic growth. From the outset, it is interesting to note the trend which this research has followed, from the initial headline estimates of a production elasticity of 0.4 in 1989 to the more modest assessments of 0.1 in 1997. The link between infrastructure investment and economic growth has been a major topic for academics since the publication of Aschauer's(1989) seminal paper which found that public investment in infrastructure was a very important source of economic growth. Aschauer (1989) considered the relationship between aggregate outputs and the stock and flow of government spending variables and concluded that 'core' infrastructure of streets, highways, airports and mass transit systems should be given more weight when

assessing the role government plays in the promotion of economic growth and productivity improvements. Aschauer's(1989) work suggested that the elasticity of output with respect to government capital was highly positive, within a range of 0.38 to 0.56. This implies extremely high returns, with the marginal product of government capital in the region of 100% per annum or more. Given these results, it is not surprising that Aschauer's(1989) work was to initiate the 'public infrastructure debate' which has since resulted in numerous academic studies.

Munnell (1992) provides an excellent assessment of the early literature on the public infrastructure debate. She shows that the main problem with Aschauer's(1989) work is that his results do not rule out the possibility that the direction of causality runs from growth to infrastructure, or that the correlations he found are spurious. Nevertheless, in response to the critics who claim that the wide range of estimates of public capital's impact on output 'make the empirical linkages fragile', Munnell (1992:193) provides evidence to suggest these claims are misleading. As illustrated in Table 1, in almost all cases the impact of public capital on private output has been found to be positive and statistically significant.

Munnell (1992) concludes that the evidence suggests that, in addition to providing an immediate demand-side economic stimulus, public infrastructure investment has a significant, positive effect on output and growth. However, she stresses that in a policy-making context 'Aggregate results cannot be used to guide actual investment spending. Only cost-benefit studies can determine which projects should be implemented' (1992:196).

Gramlich's(1994)influential paper also unpacks many of the arguments and assertions made by Aschauer (1989), along with the mass of academic literature that followed. Gram-lich (1994) begins his paper by using the narrow public-sector ownership definition as the stock of infrastructure capital – but highlights that a wider meaning could involve private infrastructure capital, human capital investment and research and development spending. This emphasises the importance of definition – what type of investment is being classified as infrastructure and what type is then being linked to economic growth. Gramlich (1994) notes that projects such as a new highway might provide a very high return, whereas main-tenance of rural roads might provide low or even negative economic rates of return; in such areas, investment objectives may be primarily social rather than economic. He applies this by showing that only two-thirds of the capital stock analysed by Aschauer (1989) even purports to raising national output – and to varying degrees – making his claims about the major positive influence of infrastructure on economic growth less plausible.

Table 1. The impact of an increase in the stock of public capital on output

Study	Focus of study	Output elasticity of public capital
Aschauer (1989)	US national	0.39
Holz-Eakin (1988)	US national	0.39
Munnell (1990a)	US national	0.34
Costa et al. (1987)	US states	0.20
Eisener (1991)	US states	0.17
Mera (1973)	Japanese regions	0.20
Munnell (1990b)	US states	0.15
Duffy-Deno & Eberts (1989)	US metropolitan areas	0.08
Eberts (1986, 1990)	US metropolitan areas	0.03

Source: Table adopted from Munnell (1992:194).

As research in the field progressed, disputes over the direction of causality between changes in productivity and investment in infrastructure became dominant. Evans & Karras (1994) analysed infrastructure and productivity data for seven Organisation for Economic Cooperation and Development countries between 1963 and 1988. The study found strong correlations between the two variables, but concluded that the direction of causality was the opposite of that reported by Aschauer (1989) and Munnell (1992). That is, increased stocks of public capital were the result of increased productivity and economic growth, not the cause. In analysing the correlation between average GDP and government net capital stock, they concluded that 'there is no evidence that government capital is highly productive' (Evans & Karras, 1994:278). Zegeye (2000) supports the Evans & Karras (1994) study, concluding that infrastructure is a normal good, where wealthy counties will tend to have more and poor counties less. Zegeye's (2000) report found that the output elasticity between public infrastructure and private investment was just 0.02.

Several other authors have attempted to resolve the question of causality, refining their methodologies to ensure they capture the results of infrastructure investments, and not the results of economic growth. A study for the Organisation for Economic Cooperation and Development by Demetriades & Mamuneas (2000) and a study by Esfahani & Ramirez (2003) handled the causality issue by introducing a 'time-lag' between variables for public infrastructure and productivity. In these studies, investments were compared with the productivity data several years afterwards, allowing time for the benefits of infrastructure investments to manifest themselves in the productivity data, and reducing the chance of misrepresentation of economic growth impacts as productivity impacts. Both studies using this technique found that public infrastructure does have a measurable impact on increasing productivity and economic growth, although not of the magnitude reported by Aschauer (1989).

Lau & Sin (1997) published an important econometric paper on public infrastructure and economic growth. This was subsequently referred to as being 'the most sophisticated subsequent econometric studies' by SACTRA (1999) and commended for taking the research some way to circumventing the 'causality' and 'definition' difficulties highlighted by Munnell (1992) and Gramlich (1994) amongst others. The authors estimate the elasticity of output with respect to public capital to be 0.11. Although this would imply a much lower marginal product of public investment than that indicated by Aschauer's (1989) original paper, it still suggests that infrastructure investment has a significant impact on output.

The South African literature on the impact of infrastructure investment on economic growth is still small and relatively recent. It has followed a similar path to the trends observed for the international literature. A good account of the literature is available in Fourie (2006). Table 2 summarises all of the studies we are aware of on the topic.

The early studies have relied on classical econometric tools while the latter studies have used more recent techniques of vector error correction models and vector autoregressions. In spite of differences in methodology, the studies report a positive output elasticity. Bogetic & Fedderke (2005) find positive effects of infrastructure on labour productivity but negative effects on total factor productivity. Their explanation for this counter-intuitive result is that infrastructure only has direct effects and no indirect effects! This is grossly at odds with predictions from received theory, where indirect effects are most important. In follow-up work, Fedderke & Bogetic (2006)

Table 2. The impact of an increase in the stock of public capital on output in South Africa

Study	Infrastructure measure (on economic growth)	Econometric technique	Output elasticity
Abedian & van Seventer (1995)	Public authorities' capital stock	OLS	0.33
	Public-sector capital stock	OLS	0.17
Development Bank of South Africa (1998)	Public authorities' capital stock	OLS	0.25
		Cointegration	0.3
	Public-sector capital stock	OLS	0.15
		Cointegration	0.28
	Public-sector infrastructure stock	OLS	0.17
		Cointegration	0.25
Fedderke et al. (2005)	Electricity generation	VECM	0.1–0.2 and rising to 0.5 after controlling for institutions
Bogetic & Fedderke (2005)	Infrastructure measures on labour productivity	VECM	0.2–0.4
	Infrastructure measures on total factor productivity	VECM	−0.6
Fourie (2006)	Electricity generation	VECM	0.2
	Electricity generation on a measure of equity performance	VECM	0.38
	Social infrastructure	VAR	0.01–0.02

Note: OLS = ordinary least squares; VAR = vector autoregressions; VECM = vector error correction models.
Source: Table adopted from Fourie (2006) and extended by the authors.

concluded that infrastructure investment had a positive impact on productivity: total factor productivity increased by 0.04% when investment in economic infrastructure increased by 1%. However, Fedderke & Garlick (2008) suggested that the Accelerated and Shared Growth Initiative – South Africa (AsgiSA) infrastructure plan might have had unfavourable effects in South Africa. Fourie (2006) finds bi-directional causality between infrastructure and growth and also finds large positive returns to infrastructure on equity. Thus, the South African econometric studies show favourable effects of infrastructure spending on growth, irrespective of the methodology used. Some even go further to argue that infra-structure on equity has higher returns than economic infrastructure.[3]

Compared with the econometrics literature, the literature on CGE applications of public capital expenditures and links to economic growth is more recent and still growing. Similar to the econometrics literature just reviewed, the findings of this literature are mixed. Whilst most studies find that the output elasticity of public expenditure is posi-tive, the magnitudes of the effects vary considerably. In a summary of some of the main studies on infrastructure, Kirstern & Davies (2008) show that, in general, studies that looked at various infrastructure sectors (roads, sanitation, electrification and dams) display varied results – some are beneficial for poverty reduction, while others actually cause poverty. Using a static CGE model, Perrault et al. (2010) explore the impact of scaling up infrastructure in six African countries with different economic structures. They find that the different economic structures lead to differences in impact of investment funded by the same sources with the same model. The analysis shows the importance of the underlying economic structure in determining

[3]Ayogu (2005) also surveys the theoretical literature on infrastructure and growth and then reviews the empirical evidence globally and within the African region. Overall he concludes that the question is not whether infrastructure matters but precisely how much it matters in different contexts. Ultimately, this is an empirical question that the literature has not yet resolved satisfactorily. In contrast, according to Ayogu, the crucial issue – understanding policy-making processes in infra-structure – remains little understood and largely under-researched.

the impact of infrastructure expenditure in a country. This suggests that the structure of the economy where these policies will be applied needs to be taken into account.

Another strand of related literature concerns itself with the effects of scaling up aid to developing countries. Received wisdom based on standard analysis came to the conclusion that scaling up aid flows would generate sustained growth and improved standard of living (Adam, 2005). This view has been challenged by authors who point out that both intended and unintended consequences, discussed largely under the rubric of what has come to be referred to as 'absorptive capacity constraints' (see for example Clemens & Redelet, 2003; Burnside & Dollar, 2004; Allen, 2005; Heller, 2005), make the impact of aid on economic growth indeterminate. A major concern in this respect is the so-called Dutch disease effect associated with scaling up foreign aid. Recent evidence (including Adam & Bevan, 2003; Allen, 2005; Heller, 2005; Bourguignon & Sundberg, 2006) has shown that the conventional Dutch disease effects may be overturned if there are productivity spillovers in both tradable and non-tradable sectors. Using Uganda as an example, Adam & Bevan (2006) construct an aggregated CGE model and demonstrate that Dutch disease-type effects can be avoided if the non-tradable sectors benefit from infrastructure investment externalities. Savard (2010) extends this kind of reasoning in three ways; namely, dropping the tradable–non-tradables dichotomy, allowing for a wider variety of funding options for infrastructure spending and introducing a top-down, bottom-up microsimulation module to allow for poverty analysis. Applying the methodology to explore the impact of scaling up infrastructure in the Philippines, Savard (2010) finds that the macro results obtained from the analysis are similar to those of Adam & Bevan (2006) and Estache (2007), although the Dutch disease effects disappear when they assume the presence of production externalities. To improve the analysis on this front, Savard (2010) suggests that a sequen-tially dynamic framework would be a more appropriate tool.

A number of recent studies have sought to make contributions along this line. For instance, Jung & Thorbecke (2003) used a recursive dynamic CGE framework and showed that infrastructure spending benefited poor people in Tanzania but worsened the plight of the poor in Zambia. A fair amount of authors investigating the impacts or challenges of scaling up aid to achieve the Millennium Development Goals (see for example Bourguignon & Sundberg, 2006; Hailu, 2007; Serieux et al., 2008) have also used this recursive dynamic approach. They use the Maquette for MDG Simulations (MAMS) model (see Lofgren & Diaz-Bonilla, 2005). This model extends static standard CGE models of the type already discussed in two key respects. First is the incorporation of recursive dynamics and second is the addition of a Millennium Development Goal module that endogenises Millennium Development Goal outcomes. The paper by Bourguignon & Sundberg (2006), based on this model for Ethiopia, concludes that the impact of large aid inflows on the Dutch disease can be serious but strategic investments to boost productivity and address trade constraints are important in addressing the adverse effects. World Bank (2005) reports a similar finding for Ethiopia based on a model that focused on aid-financed investments in human capital. Mabugu et al.(2013a) use an intertemporal CGE model to investigate the consequences of an expansive fiscal policy designed to accelerate economic growth in South Africa. The model is oriented towards constraints the government faces in financing its expenditures and explains why it takes into account the different sources of income of the South African government, its

expenditures and its deficit as well as intertemporal dynamics. The labour market faces a lot of rigidities in South Africa that the intertemporal model does not capture. Our article is fundamentally similar in spirit and conception to these CGE-based simu-lation models just described but applied to reflect the structural features of the current South African economy. Presumably, the extent to which productivity spillovers from infrastructure investments can potentially affect the economy will depend on the particular circumstances of the country. In this respect we draw from the extensive infrastructure productivity econometrics literature discussed to postulate positive productive externalities associated with new infrastructure for South Africa. Unlike Mabugu et al. (2013a), labour market peculiarities of the South African economy have been included in our modelling and dynamics are modelled as recursive rather than intertemporal. This article is intended to contribute to the discussion by providing evidence from South Africa using the economy-wide dynamic CGE model calibrated to contemporary conditions in the country.

3. Data and methodology

The original social accounting matrix used is from Quantec for 2005. The different occupations in the social accounting matrix are identified as skilled, semi-skilled and unskilled. For the purpose of this article, the labour factor is disaggregated further into occupations. Integrated economic accounts from Statistics South Africa for 2005, where the labour force is split according to occupation, are used after ensuring concordance with the social accounting matrix economic activity codes.

For modelling, Gibson (2003) is followed for the trade parameters and low-bound export supply, while demand elasticities are obtained from Behar & Edwards (2004). Unemployment rates are drawn from the labour force survey report by StatsSA (2009).

To evaluate the impacts of government's policies in the long run, we use the PEP-1-t model by Decaluwé et al. (2010). However, several assumptions of this standard model are changed in order to better represent the South African economy.[4]

The production function technology is assumed to be of constant returns to scale and is presented in a four-level production process. At the first level, output is a Leontief input–output of value added and intermediate consumption. At the second level, a Replace as Constant Elasticity of Substitution (CES) function is used to represent the substitution between a composite labour and capital. At the third level, composite labour demand is also a CES function between skilled, semi-skilled and unskilled labour. The skilled demand is then a CES with a low elasticity between legislators, professionals and technicians, capturing the fact that (for instance) it is quite difficult for the firms to substitute a lawyer for a medical doctor. The semi-skilled demand is a CES with an intermediate value of elasticity between its five components, while the unskilled demand is a CES with a high substitution value, assuming that the producer can relatively easily substitute low-skilled workers among them.

South Africa has high unemployment problems, notably for semi-skilled and unskilled labour. Moreover, unions are very strong in the country. The trade union movement is the most organised and the largest in Africa and has influenced labour and other related industrial policies. Unions negotiate salaries and wages, conditions of service, workforce

[4]The list of equations is available upon request from the authors.

restructuring and retrenchments on behalf of their members. As a result, wages and salaries are rigid, which the model takes into account by assuming a binding minimum wage for each type of worker. Thus, if the production decreases, producers will not be able to decrease their employees' salary below the minimum wage. This rigidity will also have an impact on unemployment, because if producers cannot decrease the wage bill then they will have to retrench some workers.

Following the literature review in the previous section, we introduce a productivity factor to investment in infrastructure. As mentioned, the value added for each sector is a CES composite of labour and capital. We add a productivity factor related to the stock of infrastructure in the country to the function:

$$VA_{j,t} = \left(\frac{KD_t^{INF}}{KD_{t-1}^{INF}}\right)^{\sigma_j^{INF}} B_j^{VA}[\beta_j^{VA} LDC_{j,t}^{-\rho_j^{VA}} + (1-\beta_j^{VA}) KDC_{j,t}^{-\rho_j^{VA}}]^{-1/\rho_j^{VA}}$$

where
$VA_{j,t}$ is the value added of sector j,
KD_t^{INF} is the infrastructure stock,
$LDC_{j,t}$ is the sector j aggregate labour demand,
$KDC_{j,t}$ is the demand for composite capital by sector j, B_j^{VA} is the scale parameter (CES – value added),
β_j^{VA} is the distributive parameter (CES – value added),
ρ_j^{VA} is the elasticity parameter (CES – value added) and
σ_j^{INF} is the elasticity – productivity and infrastructure.

Modelled in this way, investment in infrastructure will increase the stock of infrastructure capital (KD_t^{INF}) in the following year. If no investment is made, then the stock of infrastructure capital remains the same and there is no extra increase in value added of a given sector. The value of elasticity σ_j^{INF} is borrowed from Fedderke & Garlick (2008).

4. Policy simulations and results

This article analyses the impact of an increase in public investment, following the South African investment plan presented in Table 3. The simulated investment programme is split into three components: investment in government sectors (e.g. education, justice) that increase the stock of capital of public sectors; investment in infrastructure (e.g. roads, harbours, airports) that does not increase the stock of capital of any sectors in particular and can be considered a public good; and investment in productive sectors (e.g. investment in the energy sector) that increase the capital stock of a given sector. Based on the literature reviewed, the simulations thus take into account the effect of infrastructure productivity on the other sectors.[5] Assuming a productivity effect of infrastructure investment on other sectors means, for instance, that the construction of a bridge (investment in infrastructure) will have an impact on other sectors if the use of this bridge reduces travel time or government investment in building a road (infrastructure spending), or that constructing/renovating a harbour has impacts on other sectors: their transport margins will decrease and they will be able to trade more, using the same quantities of

[5]Refer to Mabugu et al. (2013b) for alternative scenarios without productivity effects.

Table 3. South African investment plan

	November 2010	December 2011	2012/13	2013/14	2014/15
Economic services	161.9	197.3	217.8	228.2	230.1
Energy	52.5	71.7	90.4	98.8	102.7
Water and sanitation	14.4	17.8	20.6	19.9	19.8
Transport and logistics	69.1	79.5	76.3	76.9	72.3
Other economic services	25.8	28.4	30.4	32.5	35.2
Social services	**17.2**	26.6	26.8	32.5	35.2
Health	6.7	10	9.6	13.9	15.2
Education	6	9.1	9.8	11.2	11.2
Community facilities	3.5	5.2	4.7	4.8	6.2
Other social services	1	2.4	2.6	2.6	2.7
Justice and protection services	3.8	4.1	4.4	5.1	5.8
Central government and	2.1	4.2	8	3.5	2.5
Financial services	**0.3**	**0.7**	**0.7**	**0.7**	**0.8**
Total	**185.3**	**232.9**	**257.6**	**269.9**	**274.4**

Source: Medium Term Budget Policy Statement (National Treasury, 2011:26, Table 3.2).

labour and capital. Government investment can also increase private capital stock; for instance, when government invests in a nuclear plant, it increases the stock of capital of the electricity/energy sector.

Four different ways of financing these policies are proposed. First, government totally finances the increase (i.e. government's savings are endogenous and, given the policy set up, might decrease). In the other three finance options, the government's deficit is kept constant, and the increased spending is financed through increasing direct taxes on households (FinA), increasing firms' direct taxes (FinB) and increasing indirect taxes (FinC).

4.1 Deficit-financed investment policy

This policy has a very positive impact on unemployment for all of the different types of workers both in the short and long run. The investment in infrastructure generates an increase of capital the following year, and to use these extra machines the targeted sectors (construction, electricity and public sectors) hire more workers. Moreover, to increase their production, these sectors will also increase intermediate consumption and therefore increase other sectors' production and hiring. We can point out a specific result for skilled workers; the government's activities are more intensive for skilled and semi-skilled workers, and so the impact is greater for these two types of workers. For skilled workers, unemployment disappears in 2015; and for all categories, positive impacts remain after the simulation years.

Table 4 presents the impacts on production for each sector of the economy. In the short run, most of the sectors increase their production as already explained, but in the long run quite a number of them experience a decrease. The reason why impacts on production are quite positive for most of the sectors is because these activities do not suffer a total crowding-out effect because some public investment is directly improving their production (as in the electricity sector) and all of the sectors benefit from a decrease in margin costs, due to the improvement of infrastructure in the economy. The increase in government spending also has an impact on the other sectors through an increase of intermediate demand. Given the new capital available, government sectors need extra public servants, and all types of commodities produced by the other sectors. With the

Table 4. Impact on production (% to BAU)

Sector	Short run	Long run (2020)
Agriculture, forestry and fishing	0.10	0.03
Coal mining	0.02	−0.42
Gold and uranium ore mining	0.37	4.23
Other mining	0.05	−1.76
Food	0.09	0.23
Textiles	0.18	0.92
Footwear	0.14	0.60
Coke and refined petroleum products	0.12	0.25
Non-metallic minerals	0.94	5.26
Basic iron and steel and non-ferrous metals	−0.58	−5.75
Machinery and equipment	−2.13	−17.06
Radio and telecommunication	0.78	4.60
Transport equipment	0.68	4.23
Other manufacturing	0.81	5.09
Electricity, gas and steam	0.16	2.94
Water supply	0.09	0.42
Building construction	1.86	10.81
Wholesale and retail trade	0.07	−0.18
Catering and accommodation services	0.11	−0.14
Transport services	0.07	−0.07
Communication	0.07	−0.18
Finance and insurance	−0.20	−1.44
Business services	−0.42	−4.41
Other services	0.15	1.40
Public services	0.53	8.45

Note: BAU = business as usual.

decrease of unemployment, workers also receive an increase in wages. Indeed, as the targeted activities (electricity, construction and government) need more workers to produce, they will attract skilled and semi-skilled workers mainly by offering a better wage than the other activities. Thus, to keep their workers, the other activities will also have to increase the wages they pay to their workers, which results in increased production costs. Sectors with a similar labour demand structure will find it more costly to produce and this explains why their pro-duction levels decline. The decline is also due to a drop in total investment induced by government crowd-out.

The impacts on agents are quite interesting because they differ. Households benefit from this policy because of the decrease in unemployment and the increase in wages raises household income. Note that although their transfer income from firms (dividends) decreases, overall household income increases in the long run by almost 1%. Household savings and consumption also increase, as they are fixed proportions of disposable income. Note also that the increase in household consumption has a positive impact on activities because there is an increase in the demand for consumed commodities.

Firms are suffering: the negative impact on firms is less in the short run compared with the long run. Capital income decreases, and so do firms' income and savings, because of the drop in total investment.

Government income is slightly decreasing in the long run, due to the decrease in transfers that the government receives from firms and the receipts from firms' direct taxes.

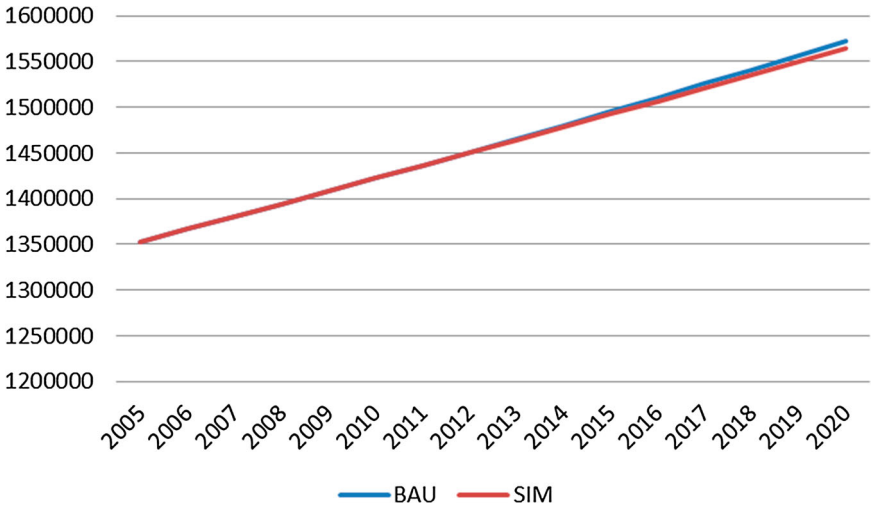

Figure 1. Impact on GDP
Note: BAU = business as usual; SIM 1 = simulation 1.

Not surprisingly, we observe a drop in the government's savings as there is no tax policy adjustment to finance the investment programme. The drop in government savings, followed by the drop in firms' savings, leads to a decrease in total investment. While a crowding-out effect of investment is evident, the impact on private investment is less harmful because a part of government investment is productive. The impact on GDP is hardly perceptible, as shown in Figure 1.

4.2 Tax-financed investment policy

The above simulation has very positive results on unemployment and benefits to households. However, in the long term, the drop in total investment tends to reduce economic growth. Moreover, it is not sustainable for South Africa to let its deficit grow unabated. Therefore, the same simulation is presented but the closure of the model is changed: the government's savings are kept fixed, and an endogenous tax finances the policy. In

Table 5. Impact on unemployment (% to BAU)

	Short run			Long run (2020)		
	FinA	**FinB**	**FinC**	**FinA**	**FinB**	**FinC**
Legislators	42.75	17.09	156.38	50.39		877.84
Professionals	67.29	36.75	185.02	171.88	−32.04	1076.57
Technicians	37.11	18.05	119.78	73.07	−34.51	606.59
Clerks	4.46	2.21	10.58	13.99	−0.81	60.01
Service workers	1.49	0.4	5.74	−4.79	−11.15	29.8
Skilled agricultural workers	7.73	3.46	14.83	38.36	8.2	88.72
Craft workers	0.37	−0.4	8	−8.44	−13.02	47.01
Plant and machine operators	2.82	0.98	10.2	6.33	−6.14	60.83
Elementary occupations	−2.77	−2.36	1.58	−24.1	−21.81	7.61
Domestic workers	1.4	0.39	4.76	3	−3.53	28.01
Occupation unspecified	1.71	0.6	5.1	5.26	−1.61	30.42

Note: BAU = business as usual.

simulation FinA, the direct tax rate of households adjusts. In simulation FinB, the direct tax rate on firms adjusts, and in simulation FinC, the indirect tax rate adjusts. The results of these three simulations are presented together.

In terms of unemployment, the results differ according to the scenario. The FinB scenario seems to be the least harmful across all categories of workers. Note that for skilled workers, as the values of unemployment were low at the base year, the percentage change looks dramatic. Note, however, that results are still very negative under simulation FinC. Indeed, under this scenario, both agents and activities are hit by the increase in the commodity tax rate (Table 5).

The impact on the sectors depends on how heavily sectors rely on investment. Activities that face an increase in their input prices (in terms of intermediate consumption) will retrench workers, and reduce their production. The impact is not uniform across sectors. Indeed, some sectors are directly favoured by the investment policy, especially the construction sector. Moreover, some sectors do not directly benefit from the policy, but as they produce investment goods their production will increase (Table 6). Once again, results under simulation FinC are very harmful for the economy.

The impact on households is negative because of the drop in transfers they receive from firms and the decrease in labour income they receive. Note that, in the long run, household income falls the least under simulation FinA; that is, when the direct tax rate adjusts.

The impact on firms is also negative, notably under simulation FinB, as they face an increase in the direct taxes they pay. Here, firms' savings drop by almost 30% in the long run, which will have a massive impact on private investment. In the three scenarios, government income increases due to the fiscal mechanism set up. Private investment

Table 6. Impact on production (% to BAU)

	FinA		FinB		FinC	
	Short run	Long run	Short run	Long run	Short run	Long run
Agriculture, forestry and fishing	−0.50	−1.20	−0.23	−0.43	−1.06	−6.00
Coal mining	0.00	3.96	0.01	2.38	−0.82	−3.47
Gold and uranium ore mining	0.55	10.05	0.47	8.46	−0.18	4.12
Other mining	0.42	7.05	0.25	3.39	−0.19	0.97
Food	−0.94	−4.52	−0.48	−2.20	−1.44	−8.53
Textiles	−1.50	−6.84	−0.74	−2.97	−2.41	−14.41
Footwear	−1.32	−6.27	−0.66	−2.89	−2.21	−13.29
Coke and refined petroleum products	−0.27	1.24	−0.09	1.12	−0.92	−4.60
Non-metallic minerals	3.03	25.42	2.08	16.73	1.97	16.45
Basic iron and steel and non-ferrous metals	0.79	9.13	0.16	2.93	−0.38	−0.51
Machinery and equipment	0.68	7.52	−0.60	−2.97	−0.65	−3.18
Radio and telecommunication	0.78	9.18	0.78	7.63	−0.49	−1.23
Transport equipment	0.80	9.06	0.74	7.33	−0.64	−2.51
Other manufactories	0.58	8.00	0.68	7.06	−0.17	1.56
Electricity, gas and steam	−1.08	−2.92	−0.51	0.12	−1.64	−8.62
Water supply	−0.99	−3.43	−0.50	−1.35	−1.52	−8.47
Building construction	5.87	43.49	4.05	29.36	4.40	32.09
Wholesale and retail trade	−0.23	1.34	−0.09	0.99	−0.91	−4.55
Catering and accommodation services	−1.34	−6.01	−0.68	−2.94	−2.11	−12.53
Transport services	−0.21	1.27	−0.08	0.93	−0.77	−3.77
Communication	−0.92	−3.24	−0.47	−1.48	−1.48	−8.63
Finance and insurance	−0.98	−3.13	−0.63	−1.74	−1.76	−9.49
Business services	−0.52	−0.77	−0.48	−2.15	−1.06	−6.25
Other services	−1.57	−7.57	−0.79	−3.31	−1.97	−11.32
Public services	0.57	10.32	0.55	9.89	0.28	6.87

Note: BAU = business as usual.

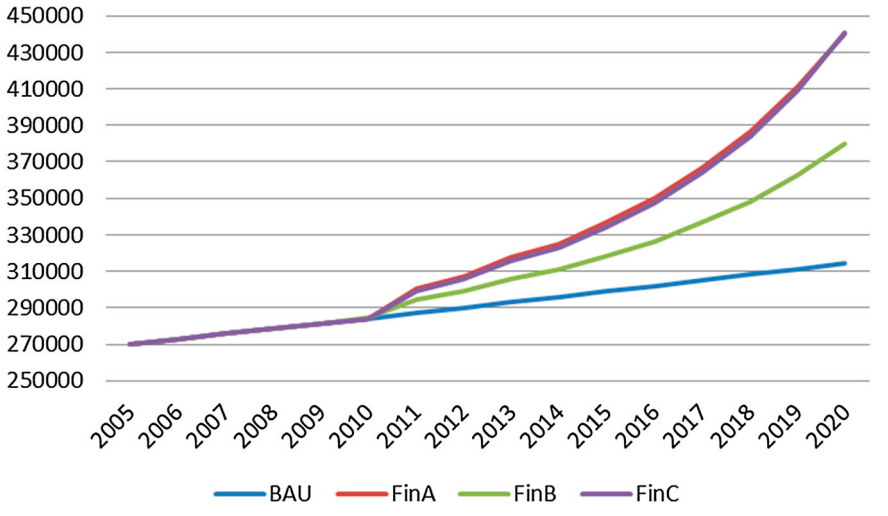

Figure 2. Impact on total investment
Note: BAU = business as usual.

decreases and is worse when firms have to finance the policy. This is because firms contribute significantly to private investment. Overall, total investment increases for each scenario (Figure 2). As public investment increases due to the policy, total investment also increases. The increase is less significant under simulation FinB.

Finally, from Figure 3 it can be observed that the policy is less harmful to GDP when financed by firms. Indeed, when households finance the policy, the impact on consumption and thus on GDP is too big. Needless to say, in simulation FinC the results are very bad. Financing the policy through an increase in indirect tax penalises the entire economy.

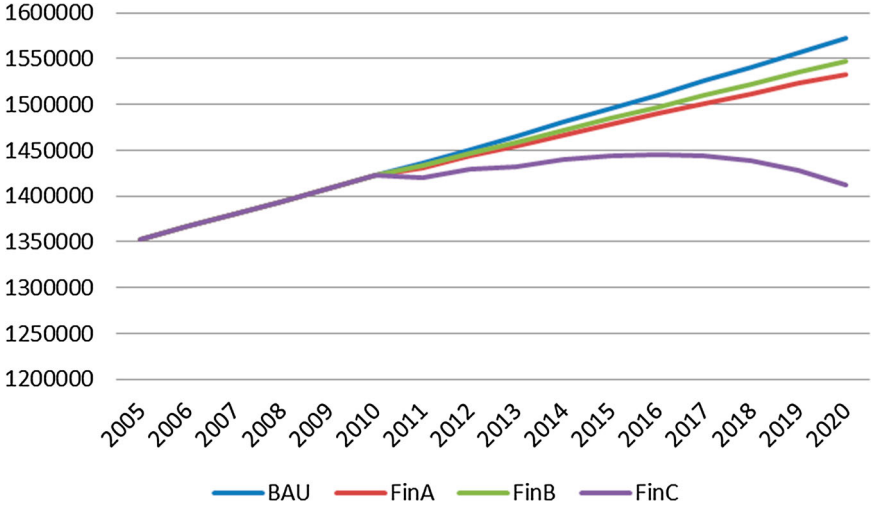

Figure 3. Impact on GDP (at basic prices)
Note: BAU = business as usual.

5. Concluding remarks and policy discussion

Long-term planning and financing challenges and the lack of a long-term strategic vision have resulted in inadequate investment in skills, infrastructure and innovation. This has led to long-standing structural weaknesses in South Africa's economy, affecting growth. In line with the NDP, government seeks to kick-start economic growth through investing in public infrastructure. There is a pressing need to harness the power of public infrastructure, given its importance for national development and regional performance. This article draws on the literature on infrastructure productivity to model dynamic economy-wide employment impacts of infrastructure investment funded with different fiscal tools. The way this investment plan has been treated in our modelling allows the government to intervene in public and private sectors of the economy. The benefits of infrastructure investment are taken into account through a productivity mechanism that will enhance other sectors. Particular attention has been paid to the labour market in the modelling. Besides improving the quality of infrastructure, the government wishes to reduce unemployment that is endemic in the country. In terms of employment, the results are quite disappointing: indeed, except under the first scenario, this investment plan is not able to generate enough activity in the economy to reduce unemployment. This article argues that South Africa should build on these aspects and, at the same time, address the inadequate institutional structures that have deterred long-term investment to support future job creation prospects.

Disclosure statement

No potential conflict of interest was reported by the authors.

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