Analysing Job Creation Effects of Scaling Up Infrastructure Spending in South Africa

By:

Margaret Chitiga (Corresponding Author) (Human Sciences Research Council, Economic Performance and Development Unit, (mchitiga@hsrc.ac.za))
Helene Maisonnave (CIRPEE, Université Laval, and PEP network, Canada (hmaisonnave@hotmail.fr)
Ramos Mabugu (Financial and Fiscal Commission, Private Bag X69, Halfway House 1685, South Africa (ramosm@ffc.co.za)
Veronique Robichaud (CIRPEE, Université Laval, and PEP network, Canada (vrob@videotron.ca))

Equal authorship is assigned.

Abstract

Typical to other developing countries, South Africa faces triple challenges of unemployment, poverty and inequality. Government economic programs are, with stronger emphasis than before, aiming at the dual objective of accelerating growth and fighting poverty and unequal access to opportunities. We draw on literature on infrastructure productivity to model dynamic employment impacts of infrastructure funded with different fiscal tools. Increased government deficit financed infrastructure spending improves GDP and reduces unemployment. However, in the long term, the policy reduces investment and is not sustainable. Increased investment spending financed by tax increases has contrasting implications on unemployment. Findings have immediate policy implications.

JEL Classification: D58, D92, H54, H59

Keywords: Employment: Dynamic CGE Model: Infrastructure Scale Up: Externalities: South Africa.

1 Introduction

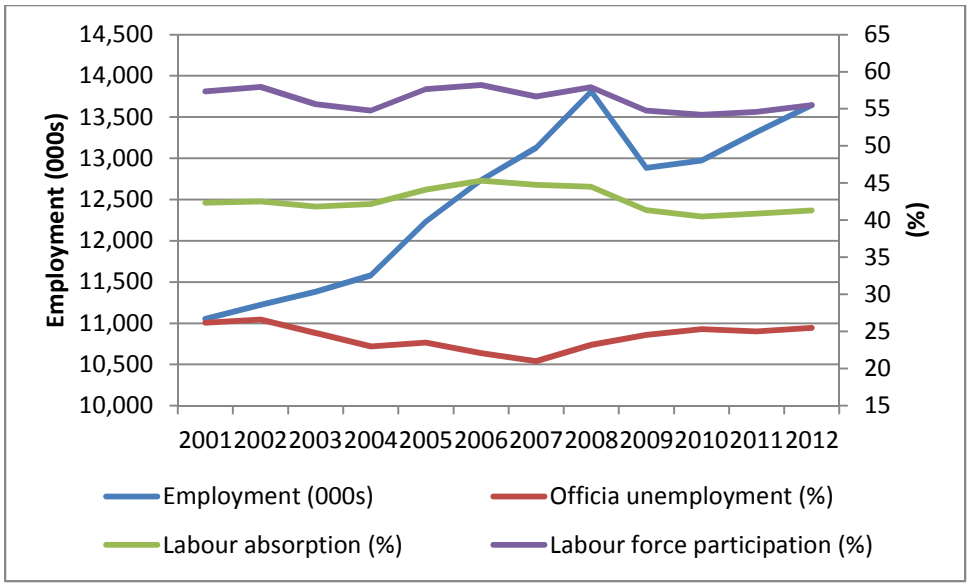
The literature on the causes of economic growth[1] presents evidence that infrastructure and capital formation are important determinants of economic growth and rising per capita incomes over time. This is a lesson that has been well learned and applied in Asian economies over the last several decades 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. During the era of Growth, Employment and Redistribution (GEAR) from 1996 to 2002, public infrastructure investment fell from 8.1% to 2.6% of gross domestic product (GDP). The emphasis during that time was fiscal discipline more than expenditure increase. It was from the Accelerated and Shared Growth for South Africa (AsgiSA) plan in 2002 that a drive for infrastructure was couched explicitly in policy. Today, the main pillars of government economic policy, the New Growth Path (NGP), the Industrial Policy Action Plan and the National Development Plan (NDP), are anchored in a significant ramping up of current and capital expenditure by the state. The government and state-owned companies plan to spend about R845bn on infrastructure over the next three years, which they expect will contribute significantly to meeting the government job-creation target of 5-million jobs in 2020 (NGP) or 11 million jobs by 2030 (NDP). So much is riding on this state infrastructure spending as the solution to reducing poverty, inequality and unemployment and generating economic growth[2].

South Africa is trapped in a cycle of modest growth, high inequality and record unemployment. The official unemployment rate fell from 26% in 2001 to 21% in 2007 and went on to peak at 25.3% in September 2010. As shown in Figure 1, both the labour absorption rate (the percentage of the working aged population who are employed) and the labour force participation rate (the percentage of those in the labour force as a percentage of working aged adults) have declined marginally during the 2001 to 2012 period. The fall in the labour absorption rate indicates that despite more people becoming employed during this period, growth in the working aged population has meant that proportionally fewer people were working in 2012 than in 2001.

Figure 1: Employment ('000s)

[1] See Aghion and Howitt (2000).

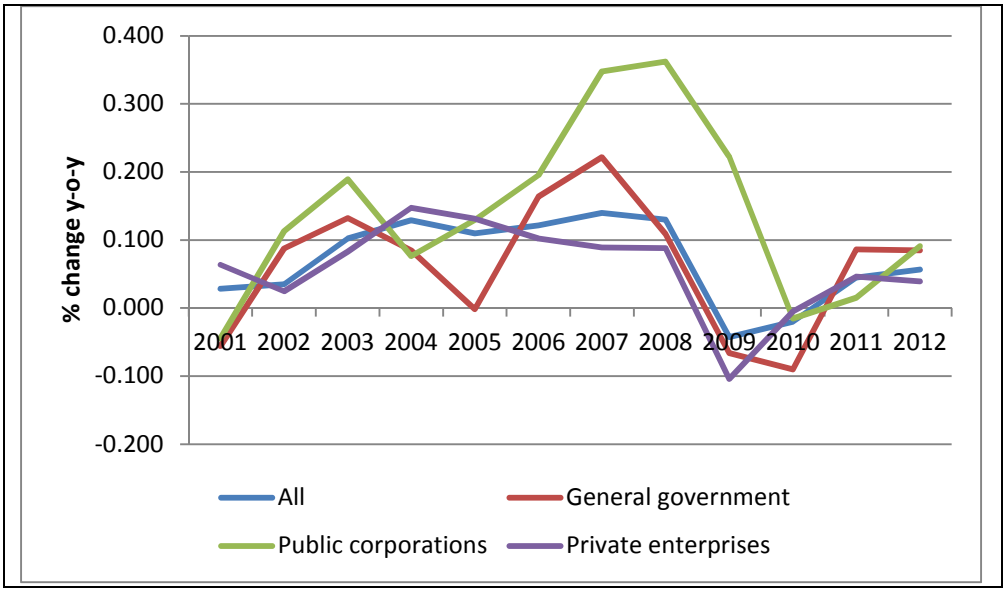
[2] In its drive to raise employment levels, the South African government has put in place a number of other policies / programmes such as the Industrial Policy Action Plan (IPAP), Expanded Public Works Programme and the Community Works Programme.



Source: Statistics South Africa's Labour Force Survey (pre-2008) and Quarterly Labour Force Survey (2008 and later). September figures.

During the period 2000 to 2012 the amount of gross fixed capital formation (GFCF) per year in South Africa, a measure of investment, more than doubled in real terms (Figure 2). Although private enterprise GFCF has increased the most in terms of levels, the highest growth rates in GFCF has been by government, especially public corporations. This surge in GFCF was driven by investment by state-owned enterprises such as Eskom, for new power generation capacity, and Transnet, to upgrade and expand rail, port facilities and pipeline infrastructure.

Figure 2: Gross Fixed Capital Formation by category, 2005 Prices year on year changes



Source: South African Reserve Bank

The question whether there are economic gains from the provision of higher levels of public spending on capital is fundamental[3]. If a higher level of capital raises the growth path of the economy then it is justifiable on both equity and efficiency grounds. Whilst the equity objectives are fairly uncontroversial, 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 permanent 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 positive multiplier effects and may, therefore, raise economic activity and thus economic growth. However, once installed will these effects drop to zero? The answer here is not clear. In a Solow - type growth model the effects on growth would be expected to be transitory, 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 to 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 paper 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 and 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. The rest of the paper is structured as follows. Section 2 reviews the literature to contextualise the study, followed by a presentation of the model and data in section 3. Section 4 presents the simulations and implications of introducing alternative infrastructure investment in such a framework. We close the paper with concluding remarks and policy recommendations in section 5.

[3] For a detailed discussion of relevant papers in this field see Aghion and Howit (2000).

2 Literature Review

(Neo) classical economics generally assumes that activist fiscal policy is unnecessary to increase employment and production. Government expenditure is generally 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 and Kurz (1970) and Aschauer (1989). During the 1980s and 1990s, there was strong academic interest (particularly in the United States of America), on the link between public investment in infrastructure and economic growth. From the outset, it is interesting to note the trend in 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 (1989)'s seminal paper which found that public investment in infrastructure was a very important source of economic growth. Aschauer (1989) considered the relationship between aggregate output 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 (1989)'s 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 cent per annum or more. This would imply that one unit of Government capital pays for itself in terms of higher output in a year or less. Given these results, it's not surprising that Aschauer (1989)'s work was to initiate the 'public infrastructure debate' which has resulted in numerous academic studies since.

Munnell (1992) provides an excellent assessment of the early literature on the public infrastructure debate. She shows that the main problem with Aschauer (1989)'s work is that his results do not rule out the possibility that the direction of causality runs from growth to infrastructure (i.e. economic growth might lead to an increase in the need for investment and/or an increase in the availability of funding), or that the correlations that 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) provides evidence to suggest these claims are misleading. As illustrated in Table 1 below, in almost all cases the impact of public capital on private output has been found to be positive and statistically significant.

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

Author	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, Ellson and Martin (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 and Eberts (1989)	US Metropolitan Areas	**0.08**
Eberts (1986, 1990)	US Metropolitan Areas	**0.03**

Source: Table adopted from Munnell (1992, p194),

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' (Munnell (1992: p196)).

Gramlich (1994)'s influential paper also unpacks many of the arguments and assertions made by Aschauer (1989), along with the mass of academic literature which followed. Gramlich (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 maintenance 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.

As research in the field progressed, disputes over the direction of causality between changes in productivity and investment in infrastructure became dominant. Evans and Karras (1994) analyzed infrastructure and productivity data for seven Organisation for Economic Co-operation

and Development (OECD) 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 and Karras (1994: p278). Zegeye (2000) supports the Evans and Karras (1994) study, concluding that infrastructure is a normal good, where wealthy counties will tend to have more and poor counties less. Zegeye (2000)'s report found 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 2000 OECD study by Demetriades and Mamuneas, and a 2003 study by Esfahani and Ramirez 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 and 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 (1989)'s 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 the studies on the topic which we are aware of.

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

Author	Infrastructure measure (on economic growth)	Econometric technique	Output elasticity
Abedian and van	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, Perkins and Luiz (2005)	Electricity Generation	VECM	0.1-0.2 and rising to 0.5 after controlling for institutions
Bogetic and 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

Source: Table adopted from Fourie (2006) and extended by authors.

The early studies have relied on classical econometric tools while the latter studies have used more recent techniques of Vector Error Correction Models (VECMs) and Vector Autoregressions (VARs). In spite of differences in methodology, the studies report a positive output elasticity. Bogetic and Fedderke (2005) find positive effects of infrastructure on labour productivity but negative effects on total factor productivity. Their explanation for this counterintuitive 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 and Bogetic (2006) 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 and Garlick (2008) suggested that the 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 infrastructure on equity has higher returns than economic infrastructure[4].

[4]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 him, the crucial issue—understanding policymaking processes in infrastructure—remains little understood and largely under-researched.

Compared to 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 find that the output elasticity of public expenditure is positive, the magnitudes of the effects vary considerably. In a summary of some of the main studies on infrastructure, Kirsten and 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, 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 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 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 Burnside and Dollar (2004); Clemens and Redelet (2003); Heller (2005);Allen (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[5]. Recent evidence (including Adam and Bevan (2003); Allen (2005); Heller (2005); Bourguignon and 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 and 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-nontradables 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 Adam and Bevan (2006) and Estache (2008), although the Dutch disease effects disappear when they assume the presence of production externalities. There are also no major differences at the macro level when taking into account funding options to scale-up infrastructure. However, poverty analysis shows stark differences and in particular

[5]The term Dutch disease refers to a phenomenon where an economic boom (normally a discovery of natural resource or large inflow of foreign currency) leads to a real exchange rate appreciation that results in increased demand for non-tradables and eventually to a decline in the economic growth rate. It was coined to describe the de-industrialisation experienced in the Netherlands in the 1960s following the discovery of natural gas in the North Sea.

the VAT funding option yields the most favourable outcomes in terms of poverty reduction when compared to the foreign aid option and the income tax option. To improve the analysis on this front, Savard (2010) suggests that a sequentially dynamic framework would be a more appropriate tool.

A number of recent studies have sought to make contributions along this line. For instance, Jung and Thorbecke (2003) use 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 (MDG) (see for example Bourguignon and Sundberg (2006), Hailu (2007) and Serieuxet al.(2008)) have also used this recursive dynamic approach. The model that is typically used in these exercises is referred to as the MAMS model (for details on the MAMS model, see Lofgren and Diaz-Bonilla (2005)). This model extends static standard CGE models of the type discussed above in two key respects. First is the incorporation of recursive dynamics and second is the addition of an MDG module that endogenizes MDG outcomes. The paper by Bourguinon and Sundberg (2006) based on theMAMS model calibrated to Ethiopian data concludes among other things, 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) report a similar finding for Ethiopia based on a model that focused on aid-financed investments in human capital.Mabugu et al (2013) 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 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 paper is fundamentally similar in spirit and conception to these CGE-based simulation 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 (2013), labour market peculiarities of the South African economy have been included in our modelling and dynamics are modelled as recursive rather than intertemporal. This paper 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[6]

The original Social Accounting Matrix (SAM) used is from Quantec for 2005. The different occupations in the SAM are identified as skilled, semi-skilled and unskilled. For the purpose of this paper, the labour factor is disaggregated further into occupations. Integrated economic accounts from Statistics South Africa (StatsSA) for 2005, where the labour force is split according to occupation and population groups, are used after ensuring concordance with the SAM economic activities codes (Table 3)

Table 3: Correspondence between occupations and skills level

Skill Category	Occupation
Skilled	Legislators (LEG) Professionals(PRO) Technicians(TECH)
Semi skilled	Clerks(CLER) Service workers(SEWO) Skilled agricultural workers(SKAG) Craft workers(CRAF) Plant and machine operators(PLAN)
Unskilled	Elementary occupations(ELEM) Domestic workers(DOM) Occupation unspecified(ONS)

The following table gives a repartition of the 11 different occupations by activity.

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

Table 4: Repartition of the labour force according to occupations and activities:

	LEG	PRO	TECH	CLER	SEWO	SKAG	CRAF	PLAN	ELEM	DOM	ONS	TOTAL
Agriculture, forestry & fishing	0,09	0,03	0,02	0,05	0,03	0,23	0,07	0,07	0,21	0,10	0,11	1
Coal mining	0,09	0,11	0,05	0,03	0,01	0,00	0,14	0,08	0,13	0,04	0,33	1
Gold & uranium ore mining	0,15	0,10	0,09	0,01	0,01	0,00	0,10	0,06	0,15	0,06	0,27	1
Other mining	0,11	0,12	0,05	0,02	0,02	0,00	0,10	0,08	0,17	0,03	0,31	1
Food	0,18	0,07	0,05	0,05	0,07	0,05	0,07	0,08	0,14	0,04	0,19	1
Textiles	0,11	0,04	0,05	0,06	0,03	0,01	0,15	0,14	0,08	0,06	0,26	1
Footwear	0,05	0,01	0,08	0,04	0,06	0,00	0,21	0,10	0,19	0,14	0,12	1
Coke & refined petroleum products	0,19	0,11	0,07	0,07	0,05	0,01	0,08	0,10	0,09	0,05	0,19	1
Non-metallic minerals	0,17	0,07	0,04	0,03	0,02	0,00	0,16	0,05	0,09	0,06	0,32	1
Basic iron &steel and non-ferrous metals	0,16	0,09	0,09	0,06	0,04	0,00	0,17	0,08	0,07	0,04	0,19	1
Machinery & equipment	0,16	0,11	0,05	0,09	0,05	0,01	0,15	0,06	0,09	0,02	0,21	1
Radio and telecommunication	0,13	0,15	0,11	0,09	0,06	0,01	0,18	0,07	0,06	0,02	0,13	1
Transport equipment	0,22	0,06	0,08	0,06	0,08	0,00	0,11	0,11	0,10	0,03	0,14	1
Other manufactories	0,16	0,09	0,07	0,08	0,04	0,01	0,17	0,07	0,06	0,03	0,23	1
Electricity, gas & steam	0,18	0,10	0,14	0,04	0,02	0,00	0,17	0,06	0,03	0,02	0,24	1
Water supply	0,19	0,07	0,11	0,05	0,03	0,03	0,04	0,09	0,14	0,04	0,21	1
Building construction	0,14	0,07	0,04	0,01	0,01	0,00	0,10	0,01	0,35	0,04	0,23	1
Wholesale & retail trade	0,20	0,07	0,07	0,14	0,10	0,01	0,13	0,04	0,10	0,02	0,12	1

Catering & accommodation services	0,23	0,04	0,05	0,10	0,25	0,01	0,04	0,03	0,09	0,03	0,12	1
Transports services	0,08	0,03	0,03	0,11	0,07	0,00	0,07	0,23	0,09	0,04	0,25	1
Communication	0,23	0,12	0,09	0,19	0,07	0,01	0,04	0,06	0,04	0,01	0,14	1
Finance and insurance	0,27	0,20	0,11	0,25	0,05	0,00	0,02	0,01	0,01	0,01	0,09	1
Business services	0,18	0,26	0,08	0,09	0,15	0,01	0,05	0,03	0,02	0,02	0,11	1
Other services	0,04	0,09	0,02	0,06	0,06	0,01	0,05	0,03	0,02	0,08	0,53	1
Public services	0,17	0,12	0,06	0,15	0,33	0,01	0,04	0,03	0,02	0,02	0,05	1

Source: Authors' calculations from the SAM

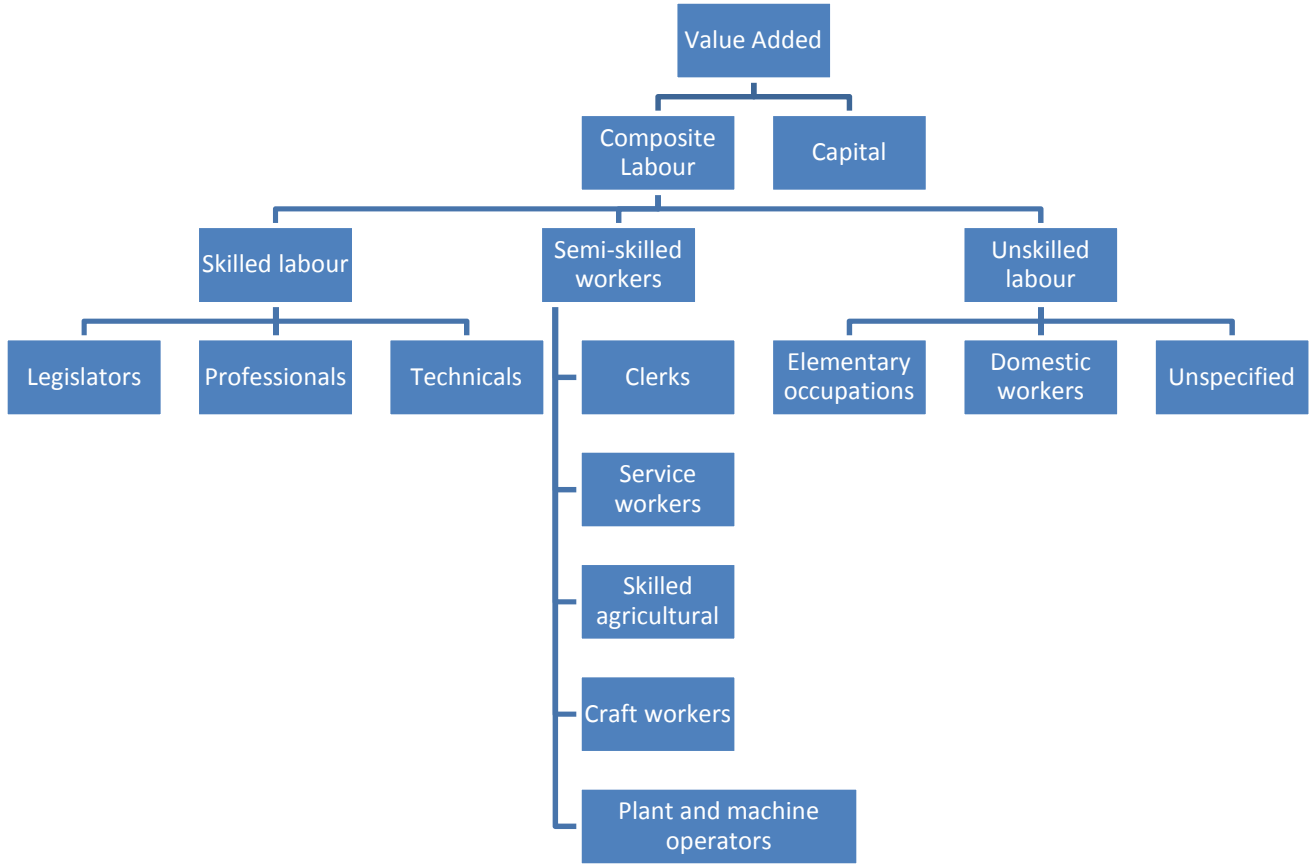
From Table 4, we can point out that the construction sector is likely to be disproportionately affected by an infrastructure investment program policy because the sector is quite intensive in low skilled workers, especially the ones identified as elementary or unspecified occupations. Moreover, legislators (LEG) represent 15% of the labour force in this particular sector.

For modelling, Gibson (2003) is used for the trade parameters and low-bound export supply, while demand elasticities are obtained from Behar and Edwards (2004). Estimates for parameters in industry production and household demand are not available for South Africa. Therefore, the study borrows these values from the literature surveyed by Annabiet al. (2006). Finally, 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, the dynamic Poverty and Economic Policy (PEP 1-t) standard model by Decaluwé et al. (2010) is used. However, several assumptions of this standard model are changed in order to take into account the South African economy. The model has two production factors: capital and labour. Labour is disaggregated into three broad types: unskilled, semi-skilled and skilled workers. Each type of broad labour is then disaggregated into occupations. Each activity uses both production factors.

In line with the SAM, the model has 25 activities and 54 commodities. 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 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. Then, the skilled demand is 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 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. Figure 3 gives the value-added structure.

Figure 3: The value-added structure



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 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[7]. 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, asif producers cannot decrease the wage bill, they will have to retrench some workers[8].

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

[7] Furthermore, note that the labour relations regulatory structure lends itself to centralised collective bargaining, both in the public and private sector. This enormously strengthens the hand of the trade unions in the formal sector.

[8] Retrenchment processes are however fairly onerous in labour legislation to ensure procedural and substantive fairness.

of labour and capital. We add a productivity factor related to the stock of infrastructure in the country to the function.

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

Where:

$VA_{j,t}$:	Value added of sector *j*
KD_t^{INF} :	Infrastructure stock
$LDC_{j,t}$:	Sector *j* aggregate labour demand
$KDC_{j,t}$:	Demand for composite capital by sector *j*
B_j^{VA} :	Scale parameter (CES – value added)
β_j^{VA} :	Distributive parameter (CES – value added)
ρ_j^{VA} :	Elasticity parameter (CES – value added)
σ_j^{INF} :	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 obtained from the existing literature.

As closure rules, we choose the nominal exchange rate as the numeraire in the model.[9] Following the assumption that South Africa is a small country, world prices are fixed. However, also assumed is the fact that South African exporters face less than infinite foreign demand for exports: to increase their market share on the world market, they need to reduce their free-on-board (FOB) export prices, increasing their competiveness with respect to other suppliers on the international market. Factor supplies are fixed in the first period and then grow, at the population rate for labour force and using an accumulation equation for capital.[10] Transfers between institutions and government's purchases of commodities are fixed at the base year and then grow at the population rate. The assumption is that the rest of the world's savings is a fixed proportion of GDP, which means that South Africa is not allowed to borrow further from the rest of the world.[11]

[9]Note that in the CGE results, a real devaluation of the rand takes the form of a generalised reduction in domestic prices.

[10] To specify the accumulation of capital, the Jung and Thorbecke (2003) function is followed.

[11] This assumption can seem strange given that the country has in the past increased their savings from abroad. However, South Africa does not want to increase substantially its current level of borrowing.

4 Policy Simulations and Results

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This paper analyses the impact of an increase in public investment, following the South African investment plan presented in the table below for the period 2012 up to 2016, and thereafter at the population rate. The simulated investment programme is split into three components (a) investment in government sectors (e.g. education, justice) that increase the stock of capital of public sectors, (b) 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 (c) 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. Assuming 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 in 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 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.

Table 5: South African planned infrastructure expenditure for consolidated general government

	Nov.-2010	Dec-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
Othereconomic 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
Communityfacilities	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 (2011), page 26 table 3.2

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). Then, in the next three finance options, government's deficit is kept constant, and the increased spending is financed through increasing direct taxes on households, increasing firms' direct taxes, and increasing indirect taxes.

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1- Deficit financed investment policy

The results of an increase in government's public investment on unemployment are shown in Table 6. The policy has a very positive impact on unemployment for all the different types of workers both in the short run (2012) and long run (2020). Government's activities are more intensive in 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 simulations years.

Table 6 : Impact on unemployment (% to Business as Usual (BAU))

	LEG	PRO	TECH	SEWO	SKAG	CRAF	PLAN	CLER	ELEM	DOM	ONS
2012	-13,93	-0,06	-5,06	-0,92	-1,72	-1,35	-1,27	-0,51	-1,88	-0,85	-0,74
2020				-14,31	-25,64	-11,89	-15,46	-12,83	-15,08	-8,74	-7,07

Table 7 presents the impacts on production for each sector of the economy. In the short run, most of the sectors increase their production, 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 total crowding out effect as some public investment is directly improving their production (as the electricity sector) and all the sectors benefit from a decrease in margins 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. To produce more, government sectors need extra public servants, buildings, and all types of commodities produced by the other sectors. With the decrease of unemployment, workers also receive an increase in wages. Indeed, as government's activities 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 production levels decline. The decline is also due to a drop in total investment induced by government crowd out.

Table 7 : Impact on Production (% to BAU)

Sectors	2012	2020
Agriculture, forestry & fishing	0,10	0,03
Coal mining	0,02	-0,42
Gold & 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 & refined petroleum products	0,12	0,25
Non-metallic minerals	0,94	5,26
Basic iron &steel and non-ferrous metals	-0,58	-5,75
Machinery & equipment	-2,13	-17,06
Radio and telecommunication	0,78	4,60
Transport equipment	0,68	4,23
Other manufactories	0,81	5,09
Electricity, gas & steam	0,16	2,94
Water supply	0,09	0,42
Building construction	1,86	10,81
Wholesale & retail trade	0,07	-0,18
Catering & accommodation services	0,11	-0,14
Transports 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

The impacts on agents are quite interesting as they differ. Households benefit from this policy because of the decrease in unemployment and the increase in wages raise household income (Table 8). 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.

Table 8 : Impact on households' income (in % to BAU)

	Labor income	Transfer income	Total income
2012	0,20	-0,17	0,06
2020	3,49	-3,26	0,91

Firms are suffering but less than in the case had investment in infrastructure been assumed to have no productivity effect. The negative impact on firms is less in the short compared to the long run. Capital income decreases, and so do firms' income and savings, because of the drop in total investment (Table 9).

Table 9 : Impact on firms' income and savings (in % to BAU)

	YFK	YF	SF
2012	-0.25	-0.22	-0.21
2020	-4.64	-4.09	-4.00

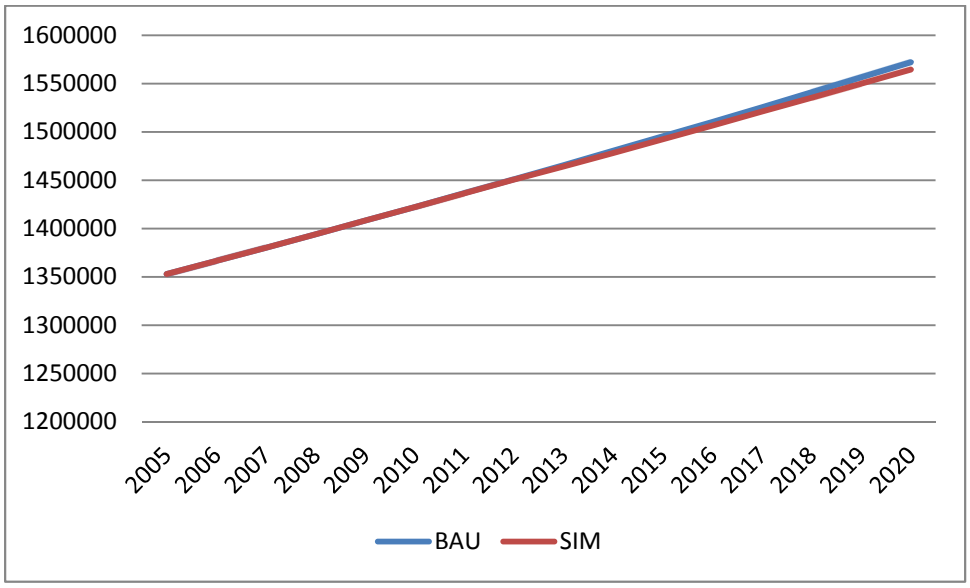
Table 10 presents all the sources of government's income and how they react to the increase in government spending. The first component represents transfer income and comes mainly from firms (dividends). The second one represents all the taxes on production (on labour, capital, production). The third one is the sum of all taxes on products (import taxes, VAT, export taxes, excise taxes, fuel levy). The final one is total direct taxes paid by households and firms. Government income is slightly decreasing in the long run, due to the decrease in transfers government receives from firms and the receipts from firms' direct taxes.

Table 10 : Impact on government (in % to BAU)

	Transfers income	Taxes on production	Taxes on products	Direct taxes on households	Direct taxes on firms	Total government income
2012	-0,21	-0,24	0,12	0,06	-0,25	-0,01
2020	-4,00	-1,26	0,86	0,91	-4,64	-0,63

Not surprisingly, we observe a drop in government's savings as there is no tax policy adjustment to finance the investment program. 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 4. With this type of policy, the idea is to see what happens in the long run. It is known that in the short run, government deficit increases a lot, but in the long run, the pressing policy issue is 'can this spending create a greater economic activity in order to generate new revenue'? For instance, a policy that creates jobs will have an impact on the fiscal side, as new workers will get income and pay new taxes (direct and indirect). The next set of simulations address this issue.

Figure 4: Impact on GDP



2- Tax financed investment policy

The first 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: government's savings are kept fixed, and an endogenous tax finances the policy. In 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, as shown in the following tables, the results differ according to the scenario. FinB scenario seems to be the less 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 look dramatic. Note though that results are still very negative under Simulation FinC. Indeed, under this scenario, both agents and activities are hit by the increase in commodity tax rate.

Table 11 : Impact on unemployment for skilled workers (% to BAU)

	LEG		PRO		TECH	
	2012	2020	2012	2020	2012	2020
FinA	42,75	50,39	67,29	171,88	37,11	73,07
FinB	17,09		36,75	-32,04	18,05	-34,51
FinC	156,38	877,84	185,02	1076,57	119,78	606,59

Table 12 : Impact on unemployment for semi-skilled workers (% to BAU)

	CLER		SEWO		SKAG		CRAF		PLAN	
	2012	2020	2012	2020	2012	2020	2012	2020	2012	2020
FinA	4,46	13,99	1,49	-4,79	7,73	38,36	0,37	-8,44	2,82	6,33
FinB	2,21	-0,81	0,40	-11,15	3,46	8,20	-0,40	-13,02	0,98	-6,14
FinC	10,58	60,01	5,74	29,80	14,83	88,72	8,00	47,01	10,20	60,83

Table 13 : Impact on unemployment for low skilled workers (% to BAU)

	ELEM		DOM		ONS	
	2012	2020	2012	2020	2012	2020
FinA	-2,77	-24,10	1,40	3,00	1,71	5,26
FinB	-2,36	-21,81	0,39	-3,53	0,60	-1,61
FinC	1,58	7,61	4,76	28,01	5,10	30,42

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. Once again, results under FinC are very harmful for the economy.

Table 14 : Impact on production (% to BAU)

	FinA		FinB		FinC	
	2012	2020	2012	2020	2012	2020
Agriculture, forestry & 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 & uranium	0,55	10,05	0,47	8,46	-0,18	4,12

ore mining						
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 & 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 &steel and non-ferrous metals	0,79	9,13	0,16	2,93	-0,38	-0,51
Machinery & 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 & 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 & retail trade	-0,23	1,34	-0,09	0,99	-0,91	-4,55
Catering & accommodation services	-1,34	-6,01	-0,68	-2,94	-2,11	-12,53
Transports 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

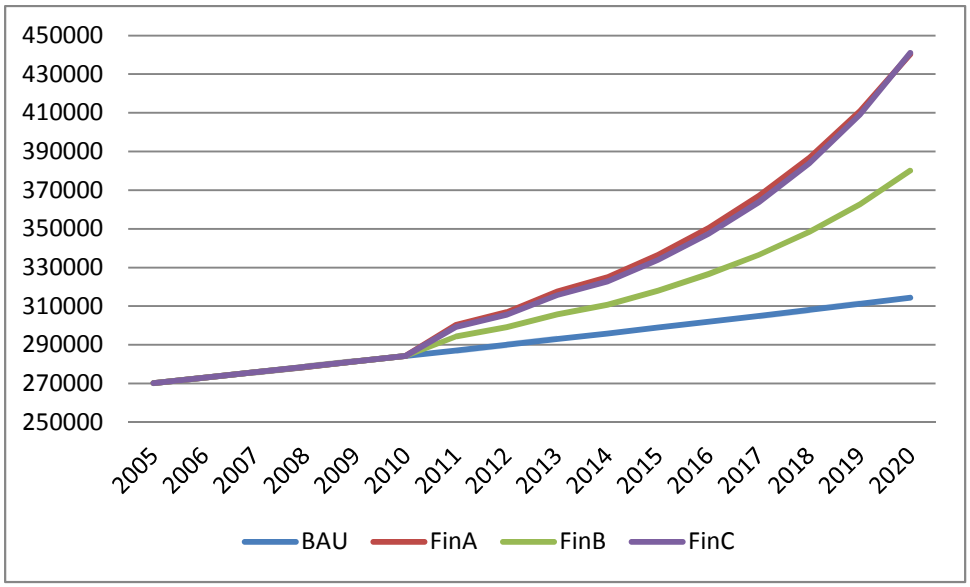
The impact on households is negative because the drop in transfers they receive from firms, and the decrease in labour income they receive (Table 15). Note that in the long run household income falls the least under FinA, that is, when direct tax rate adjusts.

Table 15 : Impact on households' income (% to BAU)

	Labour income		Transfer income		Total income	
	2012	2020	2012	2020	2012	2020
FinA	-0,42	-0,34	-0,42	-3,31	-0,42	-1,47
FinB	-0,14	1,45	-3,21	-23,21	-1,31	-7,96
FinC	-1,59	-9,11	-1,01	-8,09	-1,37	-8,72

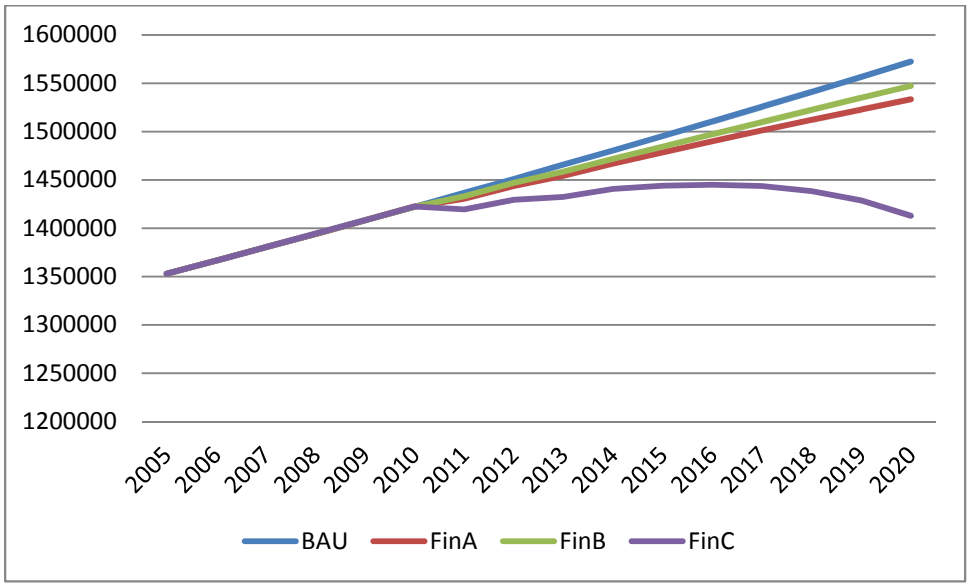
The impact on firms is also negative, notably under Simulation FinB, as they face an increase in the direct taxes they pay. Here, firms' savings drop by almost 30% in the long run, which will have a massive impact on private investment. In the three scenarios, government income increases due to the fiscal mechanism set up. Private investment 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. As public investment increases due to the policy, total investment alsoincreases. The increase is less significant under FinB (Figure 5).

Figure 5: Impact on total investment



Finally, from Figure 6 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 6: Impact on GDP (at basic prices)



5 Concluding remarks and policy discussion

This paper has analysed the investment policy the South African government plans to set up under four different fiscal scenarios. 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. If we consider a long term fiscal sustainability, VAT financing of the investment plan is pretty harsh on the economy, as it affects all the agents in the economy. Moreover, this fiscal policy would not be 'pro-poor' because all households (including the poor) are hit by an increase in VAT. The alternative financing scenario would offer some political options to the government, as it will target only households that pay direct

taxes or firms. An intermediate solution could thus incorporate a combined burden sharing between households and firms.

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