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The impact of public infrastructure investment on South Africa's economy: evidence from social accounting matrix and computable general equilibrium-based approaches

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Abstract
This paper assesses the general equilibrium impacts of public infrastructure investment in the South African economy, as a case of an emerging economy, by making use of complementary general equilibrium models, such as the social accounting matrix (SAM) multiplier, the Structural Path Analyses (SPA) and the Computable General Equilibrium (CGE) models. Contrary to studies that use partial equilibrium models, this paper shows the importance of an economy-wide model to analyse the effects of public infrastructure investment in an emerging economy. The results of the analysis, based on the SAM and CGE analyses using a 2015 SAM for South Africa, indicate that increasing public economic infrastructure can be an effective way of stimulating the economy in a way that has a positive impact on labour. SPA shows that the leading and most important path of influence is the direct influence of the public infrastructure investment on each formal labour category. However, because the public infrastructure investment does not employ informal labour, this labour account is only indirectly connected via intermediate consumption of the output of the construction sector. These results suggest that an increase in public economic infrastructure could help address the unemployment problem that exacerbates poverty in South Africa.

Keywords Public infrastructure investment · South Africa · Social accounting matrix · Structural path analysis · Computable general equilibrium

1 Introduction

Public infrastructure investment is often seen as an important driver of economic growth and a vital engine for reducing unemployment, especially in emerging and developing economies. For example, Moller and Wacker (2017) show that the rapid growth experienced by

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Ethiopia over the past decade is mostly achieved through public infrastructure investment supported by unconventional macro-financial policies. Muthu (2017) shows that contrary to some belief, public infrastructure investment crowds-in private investment in the long-run. Moreover, the author shows that public investment that aims at boosting the supply of electricity, gas and water has a considerable positive external effect on private investment and economic growth. Copeland et al. (2011) point out that not all types of public infrastructure investment contribute to a nation's productive capacity. Glomm and Ravikumar (1997) show that Public infrastructure expenditures, which enter the production function as inputs and contribute positively to final output, include the provision of roads, railway networks, airports and harbours. This is supported by Haider et al (2013) who mentioned that the impact of infrastructure is influenced by types of infrastructure as well as by economic conditions.

Most of the above-mentioned studies rely on partial equilibrium models in assessing the effects of public infrastructure investment on key macroeconomic variables. These techniques are limited in capturing the backward and forward linkages of shocks to public infrastructure investment, in particular. Public infrastructure investment is likely to have strong backward and forward linkages given its spillover effects on other sectors and institutions. General equilibrium models are most appropriate to account for the backward and forward linkages of public infrastructure investment or any other investment, as such models account for the interaction of the different economic agents, sectors and institution. However, very few studies make use of the general equilibrium model in assessing the economy-wide effects of public infrastructure investment. For example, Kim (2011) assesses the effect of transportation investment in South Korea by making use of dynamic Computable General Equilibrium (CGE). The author shows that public transportation investment affects positively economic growth but has a negative effect on inflation in the country. Mabugu and Mohamed (2008) estimated the economic impacts of financing the preparations for the hosting of the 2010 FIFA World Cup by the South African government by making use of Social Accounting Matrix (SAM) multiplier. The authors simulated an increase in expenditure for construction and upgrading of stadia amenities and related transport infrastructure. The impacts of the policy intervention were then traced on production and inputs, factor remuneration, household income and government tax revenues. Mabugu and Mohamed (2008) find that infrastructure expenditure related to the 2010 FIFA World Cup had a positive impact on the economy as shown by the change in GDP, but had regressive socio-economic impacts as indicated by the differential gains by households. Ngandu et al. (2010) assessed the economic impacts on the South African economy of the infrastructure investment that gathered momentum in the years leading to the 2010 FIFA World Cup. The authors carried out a Structural Path Analyses (SPA) of infrastructural expenditure, instead. The impact of infrastructure investment was evaluated by shocking the construction sector based on the 2003 South African SAM. The authors show that infrastructure investment linked to 2010 FIFA work cup affected positively a number of sectors and institutions in South Africa.

Assessing the general equilibrium impact of public infrastructure spending is crucial in the African continent and South Africa in particular. South Africa is trapped in a low growth path for more than a decade while the unemployment rate in the country is higher than many countries at the same stage of development than South Africa. Unemployment in South Africa waves around 27%, while economic growth stagnants below 3% on average for a decade (National Treasury 2016). While there is much talk in policy circles that increasing public infrastructure investment in South Africa may lead to job creation and improve economic growth, no study has ever provided an empirical assessment of such assumption by combining complementary general equilibium models. The questions addresses by our study are: how does investment in public infrrastructure affect South Africa's economy? What can we learn by assessing the impacts using complementary general equilibrium modelling techniques?

Previous studies, although they assess the general equilibrium effect of infrastructure investment, they however, focus either on SAM multiplier, SPA or CGE modelling without integrating the three methods. It is important to integrate the three methods, especially when assessing the economy-wide effects of infrastructure investment given the fact that SAM multiplier analysis measures sectoral linkages and quantifies production impacts only. While SPA goes beyond multiplier analysis and traces the adjustment process of the full network of influence through which an impact is transmitted within a socioeconomic system. However, CGE analysis assesses the overall impact of a shock on an economy (Khan and Thorbecke 1989).

Thus, our paper contributes to the literature of public infrastructure investment by using the three methods in a complementary way, i.e. by using SAM analysis to measure the sectoral interdependencies and trace the path of influence of increasing public economic infrastructure investment with the aid of SPA method. Then, CGE analysis is used to evaluate the economy-wide impact thereof.

To the best of our knowledge, no previous study has used multiplier analysis, structural path analysis and CGE analysis jointly to assess the impacts of public economic infrastructure investment. The rest of the paper proceeds as follows. The next section discusses briefly the data and methods used. Section 3 presents the results of the paper and Sect. 4 concludes the paper.

2 Literature review

SAM analysis has been used, and continues to be used, to understand the impacts of various socio-economic issues and policies. Previous studies have used the SAM technique to look at issues that include the impact of energy policies and prices (Akkemik 2011; Doukkali and Lejars 2015; Hartono and Resosudarmo 2008), understanding the structure of an economy (Alikaj and Alexopoulos 2014; Husain 2006; Lewis and Thorbecke 1992), investment behaviour and initiatives (Nakamura 2004; Santos 2004; Wanjala and Were 2009), the sectoral impacts of tourism (Cai et al. 2006; Jones 2010), and of agriculture (Juana and Mabugu 2005), the impacts of land reform (Juana 2006), high prices (Tlhalefang and Galebotswe 2013) and public investment and infrastructure. In South Africa, studies that have used the SAM methodology include those that have been used to analyse the impacts of sectoral growth on poverty reduction (Khan 1999), the impacts of agriculture (Eckert et al. 1997; Townsend and McDonald 1998), the mining sector (Johannes and Leeuw 2012), manufacturing and services (Tregenna 2008) and public infrastructure related issues namely the Expanded Public Works Programme (Kim 2011), 2010 FIFA World Cup related infrastructure (Mabugu and Mohamed 2008) and the economic impact of infrastructure investment (Ngandu et al 2010). Previous studies on investment and infrastructure are briefly discussed below, while the works of Mabugu and Mohamed (2008) and Ngandu et al (2010) are discussed in detail, as they are closely related to the current paper.

Nakamura (2004) looked at the investment behaviour of Russian oil and gas versus non-oil and gas industries using SAM analysis, to assess their disinclination to invest in the domestic economy. The results, Nakamura (2004) reported, showed that both oil and gas as well as non-oil and gas companies were inclined to invest financially overseas. Santos (2004) used SAM multiplier analysis and SPA to assess the components of the Portuguese government account that contribute most to an improvement in the country's net borrowing. The capital expenditure of central government, Nakamura (2004) observed, had a significant impact on the economy's net borrowing. In conclusion, Nakamura (2004) recommended a reduction in the central government's capital expenditure components, but acknowledged the effects such a reduction might have on the economy.

Wanjala and Were (2009) used the SAM multiplier analysis to assess the gender differences in employment outcomes of different investment options in Kenya. Wanjala and Were (2009) observed that women were likely to gain more from job creation; however, most of the new jobs would be in the informal sector, which is characterised by low wages. Farag and Komendantova (2014) used SAM modelling to compare the impacts of investment in various renewable energy technologies, largely for export to Europe, versus meeting local demand, in Egypt. Farag and Komendantova (2014) observed relatively higher GDP and income multipliers for the export scenario and relatively higher output multipliers for the local demand scenario. Sassi (2010) carried out a study to understand the impacts of public investment in agriculture on economic growth, poverty and food security in Kenya. Raihan (2011) assessed the economy-wide impacts of investment in infrastructure in Bangladesh using SAM modelling. Investment in both physical and social capital, Raihan (2011) observed, significantly raised gross output, GDP and household consumption.

This paper takes a different angle from the study by Ngandu et al (2010). While Ngandu et al (2010) made an invaluable contribution to the debate on impacts of public infrastructure investment in South Africa, they did not shock the actual sector that received the infrastructure investment. Shocking the construction sector cannot fully capture the impact of public infrastructure investment. As pointed out above, the public infrastructure investment drive is in fact directed largely at economic services and only impacts the private sector (which includes construction) indirectly. In addition, the main focus is of this paper is on the impacts on labour accounts, as the government seeks to make an impact on employment (Economic Development Department 2011).

3 Methodologies

This section provides the theoretical underpinnings of general equilibrium techniques. It first provides a brief discussion on the theory of SAM multiplier analysis, including backward and forward linkages. This is followed by a discussion of the theory of SPA and lastly of CGE modelling. Detailed discussions of the theoretical backgrounds of these three approaches are beyond the scope of our study, given that its focus is to assess impacts.

3.1 SAM Multiplier analysis

A SAM is a money-metric, double-entry economic accounting system that records transactions among economic activities and actors, reflecting the socio-economic structure of an economy. SAM analysis uses multipliers to model the links between economic sectors and actors at a point in time. The multiplier analysis accounts for the impacts triggered by an exogenous demand stimulus. As pointed out by Round (2003), SAM multiplier analysis allows the decomposition of these multipliers into three types of economic impacts: direct, indirect, and induced effects. According to IHS Global Inc. (2014) and Oxford Economics

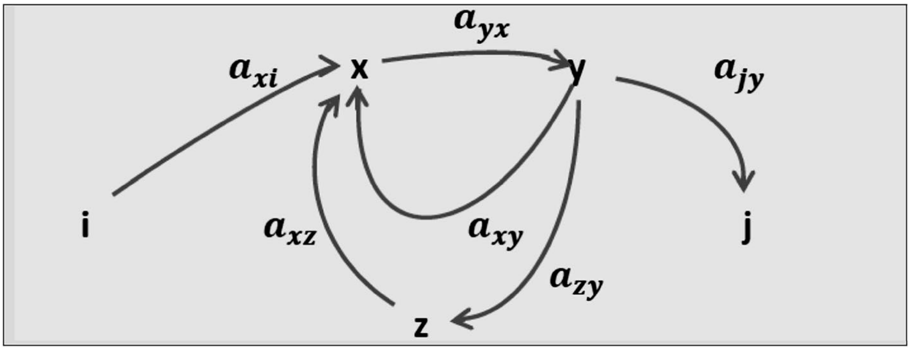

Fig. 1 Paths of influence. *Source*: Shantong et al. (2004)

(2008), direct impacts are created by the activity directly associated with the demand shock. In the present case of an increase in public economic infrastructure, this includes all the impacts caused by increased infrastructure spending. However, indirect impacts are production changes in backward-linked industries generated through the intermediate goods demanded by all sectors that are directly and indirectly affected by the direct expenditures on inputs linked to the initial infrastructure investment. Induced impacts result from changes in income and arise from the total impact on all consumer demand resulting from both direct and indirect impacts (IHS Global Inc. 2014). That is, induced impacts are created from the additional labour income received from direct and indirect industries (Oxford Economics 2008), which is then spent on consumer goods by households. The sum of direct, indirect and induced effects gives total impacts (IHS Global Inc. 2014).

3.2 SPA analysis

SPA traces how the effect of any exogenous shock on a single account travels through the complete network of a socioeconomic system. According to Defourny and Thorbecke (1984), SPA is an alternative to the traditional multiplier decomposition. In SPA, every endogenous account is likened to a pole, and any two poles i and j are connected by an arc $arc_{i,j}$ and the cell of the average expenditure propensity matrix A (of direct influences), a_{ji} is the intensity of $arc_{i,j}$ (Defourny and Thorbecke 1984; Shantong, et al., 2004). In other words, a_{ji} is the magnitude of influence of pole i on j. A path is a sequence of successive arcs and its length is measured by the number of its arcs (Defourny and Thorbecke 1984). There are two types of paths, defined by the way a path interacts with a given pole.

A path that passes through any pole only once, according to Shantong et al. (2004), is called an elementary path while a path that starts and ends in the same pole is defined as a circuit. Figure 1 shows the various paths; $i \rightarrow x \rightarrow y \rightarrow j$ is an elementary path while $x \rightarrow y \rightarrow x$ and $x \rightarrow y \rightarrow z \rightarrow x$ are circuits. There are three possible effects between accounts or poles i and j namely direct, total and global influence.

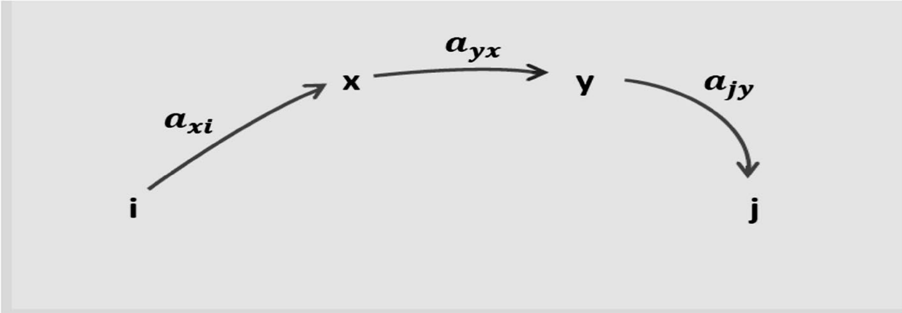

Fig. 2 Elementary path. *Source*: Defourny and Thorbecke (1984)

3.2.1 Direct influence

Defourny and Thorbecke (1984) point out that the direct path of i on j is defined as a change in j's production due to a unitary change in i, that is transmitted through an elementary path; holding all other poles constant (i.e. their production remaining constant), other than the ones along the elementary path. The direct influence of i on j, according to Defourny and Thorbecke (1984) and Shantong et al. (2004), is measured along the arc, $arc_{i,j}$, if there are only two poles, i and j, or along an elementary path if there are other poles between i and j. In a case where the path only has two poles, i and j, the direct influence is:

$$I^D_{(i \to j)} = a_{ji}$$

For an elementary path p as shown in Fig. 2, the direct influence is the product of the intensities of all arcs making up the path. The direct influence is thus calculated as:

$$I^D_{(i \to j)p} = I^D_{(i,x,y,j)} = a_{xi}a_{yx}a_{jy}$$

3.2.2 Total influence

In reality, the notion of elementary paths is very rare given the presence of feedback effects. The existence of feedback effects is well accounted for by the total influence. The total influence of i on j includes all direct effects (transmitted along the elementary path) and indirect effects (triggered by the circuits adjacent to that same path). In Fig. 2 the direct influence is $a_{xi}a_{yx}$ through the elementary path $i \to x \to y$. However, there are feedback effects transmitted from pole y back to pole x through circuits $x \to y \to x$ and $x \to y \to z \to x$. The indirect influence from pole x to pole y after one round of feedback is: $a_{yx}(a_{xy} + a_{zy}a_{xz})$. The feedback between poles x and y goes on and on, and after t rounds of feedback the indirect influence becomes: $\left[a_{yx}(a_{xy} + a_{zy}a_{xz})\right]^t$ which can be converted, using a geometric series, to: $a_{yx}\left[1 - a_{yx}\left(a_{xy} + a_{zy}a_{xz}\right)\right]^{-1}$. The total impact, including the direct influence between pole i and pole x and between pole y and pole j then becomes:

$$I^T_{(i \to j)p} = a_{xi}a_{yx}a_{jy}\left[1 - a_{yx}\left(a_{xy} + a_{zy}a_{xz}\right)\right]^{-1}$$

The first part on the right-hand side of the equation is the direct influence as defined above. The second part is called a path multiplier M_p, a measure of how adjacent feedback circuits augment the direct influence along the elementary path. Thus the equation can be rewritten:

$$I^T_{(i \to j)p} = I^D_{(i \to j)p} M_p$$

3.2.3 Global influence

The global influence from i to j is given by the accounting multiplier m_{ji}, the element of the inverse matrix M in the jth row and ith column. The global influence is thus given by:

$$I^G_{(i \to j)p} = m_{ji}$$

3.3 CGE model

CGE model is an important empirical tool to evaluate the economy-wide impact of policy shocks. It extends the SAM structure, allowing the adjustment of prices and resource reallocation between production sectors (Wei et al. 2013). They mimic the structure of the economy, and capture the economic transactions prevailing among different economic actors such as firms, households, government and productive sectors. For the sake of this paper, we use the Poverty and Economic Policy (PEP) single country static model, PEP-1-1, (Decaluwe et al. 2009) to make some simulations on the South African economy. We use the most basic model, adapted to the South African situation. Following the Walrasian approach, perfect competition is assumed in all markets, thus all markets clear, and only relative prices matter. Firms are assumed to operate in a perfectly competitive setting, maximising profits subject to their production technology. Firms are price takers, as prices of goods and services as well as factors are given.

Output in each firm is determined by a nested production function which combines value added and total intermediate consumption in fixed shares through a Leontief function at the upper level as given in the model has four agents: firms, households, government and the rest of the world. Households are disaggregated into deciles, with the 10th decile further disaggregated into three, thus giving a total of 12 households categories. Households supply capital and labour to the productive activities. In return, they receive income from the supply of labour and capital as well as transfers from other agents.

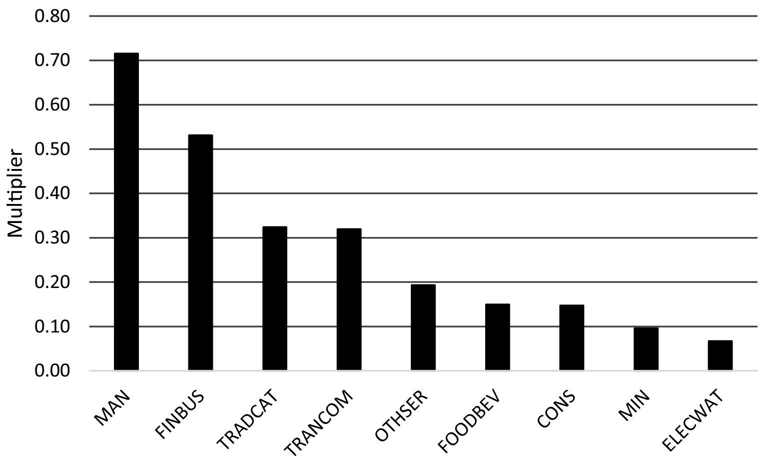

Fig. 3 Impact of the public infrastructure investment on selected sectors. *Source*: Results from SAM Modelling

4 Analysis of results

4.1 SAM multiplier analysis

The results of the SAM multiplier analysis derived from the Leontief inverse matrix for South Africa based on the 2015[1] SAM is given in Table 9 in the appendix. From the Leontief inverse, one observes that shocks to the public infrastructure investment have the greatest impact on two sectors, manufacturing (MAN) and financial and business services (FINBUS) (other than own impact of the public economic sector) as shown inFig. 3.[2] A one unit increase in final demand for the public infrastructure investment causes manufacturing and financial and business services output to increase by 0.72% and 0.53% respectively. This result is somewhat similar to that of Mabugu and Mohamed (2008) who found the third and fourth largest impact of the 2010 FIFA World Cup and related activities infrastructure expenditure on manufacturing and financial and business services. The difference is due to differences in the types of public infrastructure focused on in their paper and in the current paper.

Next, total multiplier impacts of the public infrastructure investment are analysed, in comparison with other sectors. Total multipliers, which measure the response of the economy to a change in final demand, include all types of linkages for all rounds (Breisinger et al. 2010).

[1] The 2015 SAM is the latest official South African SAM at the time of the writing of the paper. It is related to the 2005 from which some analyses are done.

[2] The full names of the remaining sectors in are as follows: trade, hotel, catering and accommodation (TRADCAT), transport, storage and communication (TRANCOM), other service activities (OTHSER), manufacture of food products, beverages and tobacco products (FOODBEV), construction (CONS), mining and quarrying (MIN), electricity, gas and water supply (ELECWAT). Table A2 in the Appendix provides a description of abbreviations of all accounts in the SAM.

Table 1 Decomposition of Public Infrastructure investment multipliers on Selected Sectors

	Multiplier				Ratio of indirect (closed-loop) effects
	Total	Transfer	Open-loop	Closed-loop	As a % of multiplier
MAN	0.72	0.28	0.02	0.42	58.5
FINBUS	0.53	0.18	0.02	0.33	61.8
TRADCAT	0.32	0.03	0.07	0.22	68.6
TRANCOM	0.32	0.10	0.02	0.20	61.6
OTHSER	0.19	0.05	0.00	0.14	72.9
FOODBEV	0.15	0.01	0.00	0.14	94.4
CONS	0.15	0.12	0.00	0.02	14.3
MIN	0.10	0.04	0.00	0.05	52.4
ELECWAT	0.07	0.02	0.00	0.05	68.5
LABHI	0.29	0	0.18	0.11	37.8
LABSK	0.36	0	0.25	0.11	30.9
LABLS	0.16	0	0.07	0.08	53.3
LABINF	0.03	0	0.01	0.02	70.4

Source: SAM modelling results

Table 2 Linkages of the public infrastructure investment with other sectors in the economy

	Chenery and Watanabe method		Rasmussen method	
	Backward	Forward	Backward	Forward
AGRI	0.56	0.32	2.97	1.31
MIN	0.48	0.38	2.85	1.93
FOODBEV	0.76	0.25	3.36	3.45
MAN	0.75	3.01	3.19	16.04
ELECWAT	0.53	0.28	2.93	1.15
CONS	0.77	0.47	3.45	1.11
TRADCAT	0.46	0.18	2.88	4.77
TRANCOM	0.57	0.76	2.95	4.88
FINBUS	0.44	1.56	2.72	8.36
OTHSER	0.49	0.39	3.10	3.46
GOVADM	0.43	0.08	3.24	0.09
GOVEDUC	0.18	0.03	3.07	0.04
GOVHLTH	0.40	0.08	3.31	0.09
GOVSOC	0.61	0.17	3.46	0.20
GOVECN	0.64	0.13	3.56	0.17

Source: Calculations from the 2015 SAM analysis

Table 1 gives the multiplier effects and their composition. Row 3 indicates that a 1% increase in the final demand for the public infrastructure investment causes a 0.72% increase in output production of manufacturing. The 0.72% total multiplier effect on manufacturing is decomposed as follows: 0.28% emanates from direct or transfer effects

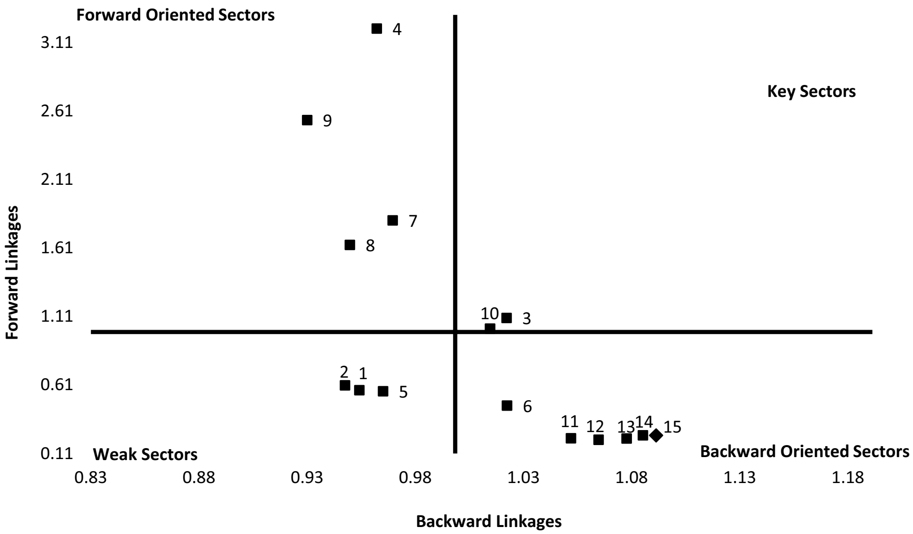

Fig. 4 Backward and Forward linkages, based on 2015 SAM. *Source*: SAM modelling results. Key: 1 = AGRI, 2 = MIN, 3 = FOODBEV, 4 = MAN, 5 = ELECWAT, 6 = CONS, 7 = TRADCAT, 8 = TRANCOM, 9 = FINBUS, 10 = OTHSER, 11 = GOVADM, 12 = GOVEDUC, 13 = GOVHLTH, 14 = GOVSOC, 15 = GOVECN

resulting from direct transfers within endogenous accounts; 0.02% comes from cross- or open-loop effects, which depict all interactions among endogenous accounts, namely factors, activities and domestic institutions; and 0.42% is from closed-loop or circular multiplier effects, which completes the circular multiplier of an exogenous injection on an endogenous account.

Furthermore, Table 1 shows that the public infrastructure investment largely impacts other industries via indirect impacts, except for the construction sector (CONS), where the indirect effect is minimal at 14.3%. This outcome indicate that the public infrastructure investment is directly linked to the construction sector. In addition, changes in the final demand for the public infrastructure investment have more direct impact on formal than informal labour as indicated in column 6, which shows that 70.4% of the impact of a change in final demand for the public infrastructure investment on informal labour is entirely indirect. This is because the sector does not employ informal labour, and thus impacts on it only indirectly. The economic adjustment process for labour accounts will become clearer under SPA in the following section.

Table 2 presents the results of the public infrastructure investment backward and forward linkages with other sectors of the South African economy. Row 3 shows that the backward (forward) linkages of the public infrastructure investment with agriculture (AGRI) are 0.56 (0.32) and 2.97 (1.31) respectively when calculated using the Chenery and Watanabe method and the Rasmussen method. Linkages calculated using the Chenery and Watanabe method are based on the direct coefficient matrix and are smaller than linkages calculated using the Rasmussen method which is based on the Leontief inverse.

Table 2 shows that construction and the public infrastructure investmenthave the strongest direct and total backward linkages of 0.77 and 3.56 respectively, as indicated in the second and fourth columns. The forward linkages of the public infrastructure investment are however quite weak. Manufacturing has the greatest forward linkages (both direct and total), largely because of its size, as well as its function as a supplier of intermediate inputs. Thus, when the public infrastructure investment receives a positive shock in the form of an expansion in infrastructure investment, such a shock triggers expansion in the whole economy through increased demand for intermediate inputs by the sector and subsequently the sectors that supply it with intermediates as they increase their production.

4.1.1 Identifying key sector(s) using backward and forward linkage indices

It is interesting to note that this method, like the Rasmussen approach, shows again that the sector of interest being studied, public economic sector, exhibits the strongest backward linkages. The sector is thus very important in terms of demanding intermediate inputs from other sectors. Hence a shock to this sector significantly impacts the economy through the change in its demand for intermediate consumption. In fact, all the public sectors are backward-oriented, which is not surprising, as they produce for final consumption. Figure 4 gives information on backward and forward linkage indices. The vertical and horizontal lines represent a value of 1. Backward-oriented sectors have a backward linkage index greater than 1 and lie on the right-hand side of the vertical line, while forward oriented sectors have a forward linkage index greater than 1 and lie above the horizontal line. Key sectors have both backward and forward linkage indices greater than 1 and are in the top right quadrant while weak sectors have both backward and forward linkage indices less than 1 and lie in the bottom left quadrant. Figure 4 shows that food and beverages (3 = FOOD-BEV) is a key sector with both forward linkage and backward linkage indices above 1.

The analysis presented in Fig. 4 shows that manufacturing; financial and business services; transport and communication; and trade, hotel, catering and accommodation are forward-oriented sectors, in that order from the strongest (manufacturing). This is expected of the manufacturing sector, since it largely uses primary inputs such as agriculture and mining output to produce textiles, wooden products, metals, refined petroleum products, chemicals, plastic and rubber, which in turn are used as intermediate inputs in many other sectors, including manufacturing itself.

Food and beverages and other services are the key sectors, with both above average backward and forward linkages; the two sectors are thus important both as suppliers and demanders of intermediate inputs. Three sectors, agriculture, mining and electricity and water prove to be neither forward- nor backward-oriented. Even though electricity and water is used in all sectors, the sector accounts for only between 0.3 and 4.8% of total intermediate consumption by other sectors. On the other hand, the electricity and water sector consumes only between 0.2 and 8.3% of the total supply of intermediate commodities by other sectors.

4.2 Structural path analysis of the economic services sector

Since in South Africa public economic infrastructure is believed to be key in the creation of the much-needed new jobs, it is worth noting how an exogenous shock on the public infrastructure investment travels through the economy, to labour accounts. SPA is thus used to trace this sector's impact on labour. As discussed above, the account multiplier, which is equal to the global influence, is the corresponding cell of the Leontief inverse matrix. The SPA results give information on the global effect, elementary paths, direct and total influence, path multiplier and the share of the global influence that is carried through the total

Table 3 Structural path analysis of the economic services sector

Path destination	Global influence	Elementary paths	Direct influence	Path multiplier	Total influence	Total (% of global)
LABHI	0.2886	AGOVECN → LABHI	0.1164	1.3249	0.1542	52.3324
		AGOVECN → CFINBUS → AFINBUS → LABHI	0.0083	1.9764	0.0165	5.5969
		AGOVECN → CMAN → AMAN → LABHI	0.0044	2.3728	0.0104	3.5441
		AGOVECN → CMAN → TCM → CTRADCAT → ATRADCAT → LABHI	0.0023	2.5365	0.0059	1.9905
		AGOVECN → CCONS → ACONS → LABHI	0.0025	1.7546	0.0043	1.4720
		AGOVECN → CTRANCOM → ATRANCOM → LABHI	0.0020	1.7297	0.0035	1.1858
LABSK	0.3638	AGOVECN → LABSK	0.1801	1.3299	0.2396	65.8466
		AGOVECN → CMAN → AMAN → LABSK	0.0045	2.3787	0.0108	2.9551
		AGOVECN → CFINBUS → AFINBUS → LABSK	0.0049	2.0233	0.0099	2.7315
		AGOVECN → CMAN → TCM → CTRADCAT → ATRADCAT → LABSK	0.0029	2.5305	0.0073	1.9957
		AGOVECN → CTRANCOM → ATRANCOM → LABSK	0.0039	1.7172	0.0068	1.8597
		AGOVECN → COTHSER → AOTHSER → LABSK	0.0024	1.5468	0.0037	1.0118
LABLS	0.1564	AGOVECN → LABLS	0.0284	1.2959	0.0368	23.5044
		AGOVECN → COTHSER → AOTHSER → LABLS	0.0068	1.4900	0.0101	6.4397
		AGOVECN → CMAN → AMAN → LABLS	0.0036	2.3616	0.0085	5.4120
		AGOVECN → CCONS → ACONS → LABLS	0.0046	1.7160	0.0080	5.0997
		AGOVECN → CTRANCOM → ATRANCOM → LABLS	0.0020	1.6948	0.0034	2.1471
		AGOVECN → CMAN → AMAN → CMIN → AMIN → LABLS	0.0011	2.3901	0.0026	1.6800
		AGOVECN → CMAN → TCM → CTRADCAT → ATRADCAT → LABLS	0.0009	2.5374	0.0024	1.5346
		AGOVECN → CFINBUS → AFINBUS → LABLS	0.0010	2.0208	0.0020	1.3044
		AGOVECN → LABSK → HHD8 → COTHSER → AOTHSER → LABLS	0.0010	1.6994	0.0018	1.1337

Table 3 (continued)

Path destination	Global influence	Elementary paths	Direct influence	Path multiplier	Total influence	Total (% of global)
LABINF	0.0307	AGOVECN → CCONS → ACONS → LABINF	0.0014	1.5800	0.0022	7.2886
		AGOVECN → CMAN → TCM → CTRADCAT → ATRADCAT → LABINF	0.0008	2.4332	0.0018	5.9738
		AGOVECN → CFINBUS → AFINBUS → LABINF	0.0008	1.8914	0.0016	5.0876
		AGOVECN → CTRANCOM → ATRANCOM → LABINF	0.0008	1.5866	0.0013	4.1869
		AGOVECN → CMAN → AMAN → LABINF	0.0006	2.2555	0.0012	4.0708
		AGOVECN → CTRADCAT → ATRADCAT → LABINF	0.0004	1.4975	0.0007	2.1561
		AGOVECN → COTHSER → AOTHSER → LABINF	0.0004	1.4329	0.0006	2.0224

Source: SAM modelling results

(direct and indirect) influence of each elementary path. Focusing on the public economic sector, the paths through which an exogenous shock to the sector's final demand influences labour accounts are traced.

The results are given in Table 3, where arrows indicate the channels through which income or output is affected across commodities, activities and factors. The global influence (which is the Leontief multiplier as given in Table 1 Row 12) of the public infrastructure investment on high skilled labour (LABHI) is 0.29, thus a Rand increase in exogenous demand for the public infrastructure investment raises high skilled labour income by R0.29. Table 3 indicates that the influence of the public infrastructure investment on high skilled labour is the main path of influence (Row 2, Column 3), and is the shortest and most direct path, through which 52% (as indicated in Column 7) of the global influence is transmitted. Row 3 to Row 7 down Column 3 in Table 6 represent indirect effects of the public infrastructure investment on high skilled labour.

For skilled labour (LABSK), the global influence is 0.36. The most important path is the impact of the public infrastructure investment on skilled labour: 66% of the global influence is transmitted through this path. The global influence for low-skilled labour (LABLS) is 0.16, and the most important path (the public economic sector) impact accounts for 24% of the global influence. Because the public infrastructure investment does not employ informal labour (LABINF), the most important path of an exogenous demand shock of the former on the latter is public infrastructure investment having an impact on construction, and construction impacting on informal labour. For each of the four labour categories, manufacturing is in two elementary paths, showing its importance in the transmission of income from the public infrastructure investment to the labour accounts. Trade, hotel and catering services is an equally important sector for the informal labour.

4.3 CGE Analysis

4.3.1 Simulations

Despite the investment in public infrastructure over the years, Lombard et al. (2017) point out that infrastructure backlogs persist in South Africa. Jordaan and Coetzee (2021) complements the argument mentioning that the country needs to invest heavily in economic infrastructure to close the infrastructure investment gap. For example, between 2010 and 2015, the average annual increase in public economic infrastructure was 8%. Thus, substantially more than this is required to meet South Africa's infrastructure needs. In fact, the government at some point planned a rate of growth in public capital budget of between 15 and 20% per year (Kularatne, 2006). We simulate a 20% increase in the public infrastructure investment capital, which is financed by a 10% increase in indirect taxes. We choose to fund the increase in infrastructure investment through taxation to avoid deficit financing which negatively impacts the economy. In addition, we simulate a 5% increase in current government expenditure on goods and services, as increasing infrastructure investment is accompanied by an increase in current spending as the public sector needs to hire more labour and also as it increases consumption of its output.

4.3.2 Closures

A savings-driven closure, where total investment expenditure is equal to the sum of agents' savings, is adopted. Thus investment is endogenous and depends on available savings. The

Table 4 Macro results (% change)

	Percentage change from base
GDP	1.1
Total investment expenditures	– 1.12
Consumer price index	1.06

Source: Simulation results

Table 5 Selected sectoral results (% change from base)

	Price of composite commodity i	Domestic demand for commodity i produced locally	Total intermediate demand for commodity i	Industry j demand for composite labour
AAGRI	0.80	– 0.44	– 0.52	– 1.54
AMIN	– 0.05	– 0.71	– 0.83	– 1.00
AFOODBEV	1.65	– 0.42	– 0.46	– 1.09
AMAN	0.96	– 0.82	– 0.53	– 1.85
AELECWAT	0.51	– 0.27	– 0.40	– 0.65
ACONS	0.93	– 1.66	– 0.89	– 3.14
ATRADCAT	1.02	– 0.61	– 0.29	– 1.24
ATRANCOM	0.68	– 0.47	– 0.32	– 1.27
AFINBUS	0.60	– 0.45	– 0.33	– 1.01
AOTHSER	1.23	– 0.30	– 0.01	– 0.49
AGOVADM	1.72	3.21	3.03	3.74
AGOVEDUC	1.96	2.97	2.61	3.44
AGOVHLTH	1.48	3.45	3.26	3.69
AGOVSOC	1.49	3.44	3.35	4.01
AGOVECN	0.08	4.89	4.73	3.58

Source: Simulation results

exogenous variables are the nominal exchange rate, which is used as the numeraire, the current account, current government expenditure, capital supply, labour supply, the world price level and inventories. Capital is assumed to be sector-specific, since this is a static model depicting the short run, thus it cannot move across sectors. World prices of imports and exports are assumed to be exogenous because South Africa is a small economy with no influence on global prices and thus takes world prices as given.

4.3.3 Results analysis

4.3.3.1 Macro results The results indicate that increasing public economic infrastructure has overall mixed macroeconomic results on the South African economy. GDP increases by 1.1%, but total investment spending declines by 1.12%, while consumer prices increase by 1.06%, as given in Table 4.

4.3.3.2 Sectoral results Raising the indirect tax rate on commodities raises the price at which these commodities are purchased. This is the case for all sectors except min-

Table 6 Sectoral production, exports and imports

	Imports			Exports			Domestic production		
	BASE	SIM	VAR (% change)	BASE	SIM	VAR (% change)	BASE	SIM	VAR (% change)
AGRI	4757	4744	− 0.30	15,889	15,753	− 0.85	78,981	78,566	− 0.52
MIN	49,333	48,840	− 0.96	99,196	98,943	− 0.26	180,443	179,683	− 0.42
FOODBEV	12,787	12,778	− 0.10	15,045	14,888	− 1.04	170,568	169,748	− 0.48
MAN	292,393	291,251	− 0.36	187,115	184,952	− 1.16	855,576	847,879	− 0.90
ELECWAT	11	11	− 0.19	444	443	− 0.30	65,847	65,676	− 0.26
CONS	400	397	− 0.58	82	81	− 1.70	145,282	142,700	− 1.78
TRADCAT	11,040	11,032	− 0.08	10,161	10,065	− 0.94	368,501	366,287	− 0.60
TRANCOM	38,785	38,851	0.13	27,840	27,612	− 0.82	318,767	317,172	− 0.50
FINBUS	14,680	14,622	− 0.41	21,532	21,455	− 0.36	513,039	511,084	− 0.38
OTHSER	10,850	10,876	0.20	5523	5471	− 0.95	167,308	166,749	− 0.33
GOVADM							130,438	134,630	3.21
GOVEDUC							95,706	98,547	2.97
GOVHLTH							46,456	48,059	3.45
GOVSOC							34,263	35,443	3.44
GOVECN							28,101	29,474	4.89
TOTAL	435,036	433,401	− 0.38	382,827	379,662	− 0.83	3,199,276	3,191,696	− 0.24

Source: Simulation results

ing. The price of mining declines marginally, which is most probably attributable to a very low indirect tax rate on mining. As a result of an increase in prices of goods and services across sectors, the demand for goods and services declines for all private activities, which consequently forces their production to fall. As shown in Table 5, the sectors whose domestic demand is worst affected are construction, manufacturing and mining, which declines by 1.66%, 0.82% and 0.71% respectively. In turn, the first two sectors suffer most in terms of output production, which falls by 1.78% and 0.9% respectively for construction and manufacturing (see Table 6). This is followed by agriculture, whose output declines by 0.52%. These results confirm the findings from multiplier analysis as construction and manufacturing have the greatest backward and forward linkages with the public economic sector.

As output falls, demand for intermediate consumption and for labour correspondingly decline. Even though domestic demand for agriculture does not fall very much relative to other sectors, demand for its output used for as intermediate inputs is the fourth worst affected, declining by 0.52%, after construction, mining and manufacturing with decreases of 0.89%, 0.83% and 0.53% respectively as given in Table 5, column 4. This is largely because food and beverages as well as manufacturing, which together demand 93.78% of agriculture output for intermediate consumption, experience significant decline in their output production. Demand for composite labour declines for all private sectors, the worst affected being construction, manufacturing and agriculture with declines of 3.14%, 1.85% and 1.54% respectively.

However, a different outcome is observed for the public sectors. While the prices of public sector commodities also rise, output production for these sectors increases. This is because there are two transmission channels for the shock for public sectors, an increase in prices and an increase in spending. Hence, the increase in public sector current spending enables government to demand more commodities despite an increase in their prices. In this case, the price increase is outweighed by the increase in current public spending and the net effect is an increase in demand for the public goods and services. Analogous to the case of private activities, as demand for public sector commodities increases, their output production increases which consequently results in an increase in intermediate consumption and labour demand to meet the required increase in output. In addition, a relatively larger impact for public infrastructure investment changes in domestic demand, output production and intermediate input consumption are observed. This is largely because it is the sector that receives the shock, hence the marginal increase in the price of its commodities.

Table 6 gives the impact on imports, exports and domestic production. Row 3 shows that the increase in capital for the public infrastructure investment results in a 0.3% decline in imports, 0.85% decrease in exports and 0.52% decline in domestic production for agriculture. The increase in the prices of goods and services makes it more expensive to consume both domestically produced and imported commodities. This is evidenced by the general decline in imports, as shown in Table 6. In addition, an increase in the price level for South African commodities makes them relatively more expensive on the world market. As a result, export demand falls. Overall, export demand falls more than imports which results in a decline in income of the rest of the world, given that savings are assumed to be fixed.

4.3.3.3 Factors of production The increase in demand for labour by public sectors following increased output production requires the public sectors to pay higher wages to attract additional labour. As a result, other sectors need to increase the wages they pay in order to keep their workers, which causes an overall upward movement in the composite wage rate,

Table 7 Sectoral labour results (% change)

	Wage rate	Demand for type of labour by industry			
		High skilled workers	Skilled workers	Low skilled workers	Informal workers
AGRI	0.26	– 2.23	– 2.83	– 1.25	– 0.54
MIN	0.03	– 1.67	– 2.26	– 0.68	0.04
FOODBEV	0.25	– 2.21	– 2.80	– 1.22	– 0.51
MAN	0.34	– 2.08	– 2.68	– 1.10	– 0.39
ELECWAT	0.31	– 1.09	– 1.69	– 0.09	0.63
CONS	– 0.30	– 2.84	– 3.43	– 1.87	– 1.16
TRADCAT	0.42	– 1.48	– 2.07	– 0.49	0.23
TRANCOM	0.37	– 1.65	– 2.25	– 0.66	0.05
FINBUS	0.56	– 1.52	– 2.12	– 0.53	0.19
OTHSER	– 0.16	– 0.87	– 1.48	0.12	0.84
GOVADM	0.83	4.77	4.13	5.82	
GOVEDUC	0.83	4.65	4.02	5.70	
GOVHLTH	0.83	4.56	3.92	5.60	
GOVSOC	0.83	4.84	4.20	5.89	
GOVECN	0.83	0.62	0.01	1.63	

Source: Simulation results

Table 8 Results for institutions

	Savings	Income	Consumption
Firms	– 0.67	– 0.71	–
Government	8.68	3.62	3.34
Households	0.59	0.64	– 0.39
Rest of the World		– 0.39	– 0.83

Source: Simulation results

as shown in Table 7. For public sectors, demand for labour increases across all labour categories (see column 2–3 of Table 7). However, demand for formal labour declines for all private sectors owing to the combined effect of the increase in the cost of labour and the decline in output production. Demand for informal labour, which is employed by private activities only, increases across all sectors with the exception of agriculture, food and beverages, and construction. As production declines in the private formal sectors, some workers are likely to be absorbed by the informal sector. Capital is fixed, as the model is static.

4.3.3.4 Institutions Results for institutions are given in Table 8. The overall decline in output across sectors results in a fall in firm income and savings. Household income generally increases mainly because of the increase in wage rates across all sectors. Even though labour demand by private activities declines, this is outweighed by the increase in wages combined by the increase in demand for labour by the public sectors. Thus the net effect is an increase in household income and consequently an increase in household savings. While government income increases, its savings decline (increase in deficit) as the increase in public economic sector's infrastructure investment is partly deficit-financed. Income of the rest of the world declines because of the relatively greater decline in export demand in comparison to the decline in imports. Even though households earn more income following the increase in capital investment by the public economic sector, consumption by households generally declines because of the increase in prices.

5 Conclusion

Public infrastructure investment is widely believed to have a positive impact on the economy. However, the conditions of an economy, as well as the type of infrastructure, play a significant role in influencing the impact of infrastructure investment. Moreover, a job creation policy that is appropriate for the economic conditions of a country is complex and requires detailed analysis of the employment potential of the different sectors of the economy. Using a 2015 South African SAM, this paper carried out multiplier analysis and SPA to assess the impact of increasing public economic infrastructure in South Africa to see how the public infrastructure investment relates with other sectors and labour accounts. The SAM has public sectors which include a public economic sector. All the public sector economic infrastructure investment spending goes to services that fall within the public economic sector.

This paper carried out multiplier analysis to assess the impact of the public infrastructure investment on the economy in relation to the impact of other sectors. It analysed backward and forward linkages to see the importance of the public infrastructure investment as a demander and supplier of intermediate inputs across the economy. In further carried out an SPA to trace the main paths of influence of the public infrastructure investment on the economy. In addition, a CGE analysis, which captures the feedback effects across production, income and demand structures and calibrates price and quantity changes in product and factor markets better than SAM analysis, was used to assess the economy-wide impacts of an increase in public economic infrastructure investment in South Africa.

An analysis of the multipliers shows that among all sectors, the public infrastructure investment has the greatest impact on manufacturing and financial and business services. A unitary exogenous increase in final demand for the public infrastructure investment triggers an increase in output for manufacturing and financial and business services output of 0.72 and 0.53 respectively; a result comparable to that of Mabugu and Mohamed (2008). On the other hand, a one unit increase in the final demand for the public infrastructure investment results in the following increases in labour income: 0.29 for high skilled labour, 0.36 for skilled labour, 0.16 for semi-skilled labour and 0.03 for informal labour. This is because the public infrastructure investment is directly connected to the formal labour categories. The public infrastructure investment has the highest output multipliers as well as relatively high GDP and income multipliers, compared to other sectors.

Backward and forward linkage analysis reveals that the public infrastructure investment displays the strongest backward linkages and is thus very important in terms of demanding intermediate inputs from other sectors. Hence a shock to this sector significantly impacts the economy through the change in its demand for intermediate consumption. SPA shows that the main and most important path of influence is a direct influence of the public infrastructure investment on each of the formal labour categories. However, because the public infrastructure investment does not employ informal labour, this labour account is only connected indirectly via intermediate consumption of the construction sector output.

SAM analysis reveals that the public infrastructure investment is an important sector in the South African economy as a shock to this sector in the form of an increase in infrastructure investment triggers a positive effect on the whole economy in terms of an increase in output. The public infrastructure investment also influences the economy largely via formal labour.

Results from the CGE analysis indicate that increasing public economic infrastructure investment in South Africa has an overall positive impact as measured by an increase in GDP, labour income, government income and household income and savings. However, the increase in public infrastructure investment does not come without costs, as the general price level increases. This has a negative impact on aggregate investment, which declines by 1.12%. This is costly for private sector activities, which are affected negatively, as the private sector investment is crowded out by public investment. As a result, production falls for the private activities, which consequently reduces firm income and savings.

The Both the SAM and CGE analyses indicate that increasing public economic infrastructure can be an effective way of stimulating the economy in a way that has a positive impact on labour. The results from CGE modelling confirm results from SAM modelling. This is an important outcome for South Africa, as the results suggest that an increase in public economic infrastructure could help address the problem of unemployment as well as that of low income levels that exacerbate poverty. Thus, the South African government should consider formulating and implementing policies that increase public economic infrastructure, given their positive impact on job creation. It is important, however, to note that while the results of this static CGE model give valuable insights, they are limited as they do not capture cumulative impacts of increasing public infrastructure investment. The two methods complement each other in that SAM analysis measures sectoral interdependencies, tracing the transmission of increasing investment in public economic infrastructure through SPA, while CGE analysis captures the economy-wide impacts.

Appendix

See the Table 9.

Table 9 Leontief inverse

	AAGRI	AMIN	AFOOD-BEV	AMAN	AELECWAT	ACONS	ATRAD-CAT	ATRAN-COM	AFIN-BUS	AOTH-SER	AGO-VADM	AGOVE-DUC	AGO-VHLTH	AGO-VSOC	AGO-VECN
AAGRI	1.083	0.049	0.299	0.052	0.048	0.049	0.054	0.047	0.046	0.059	0.061	0.068	0.064	0.059	0.061
AMIN	0.084	1.077	0.076	0.185	0.214	0.133	0.067	0.079	0.066	0.075	0.082	0.075	0.086	0.080	0.096
AFOODBEV	0.173	0.129	1.228	0.117	0.125	0.121	0.144	0.122	0.123	0.156	0.162	0.183	0.171	0.158	0.150
AMAN	0.680	0.605	0.613	1.771	0.543	0.771	0.544	0.657	0.524	0.612	0.678	0.615	0.687	0.649	0.716
AELECWAT	0.061	0.076	0.063	0.063	1.225	0.057	0.062	0.066	0.055	0.065	0.063	0.065	0.069	0.062	0.067
ACONS	0.032	0.038	0.032	0.029	0.099	1.327	0.052	0.036	0.056	0.043	0.043	0.032	0.036	0.039	0.147
ATRADCAT	0.302	0.265	0.328	0.306	0.252	0.302	1.263	0.288	0.245	0.289	0.313	0.306	0.322	0.304	0.324
ATRANCOM	0.272	0.368	0.260	0.258	0.237	0.247	0.301	1.347	0.251	0.268	0.287	0.277	0.292	0.307	0.320
AFINBUS	0.365	0.397	0.484	0.431	0.376	0.481	0.599	0.446	1.587	0.641	0.496	0.489	0.507	0.667	0.531
AOTHSER	0.145	0.156	0.170	0.143	0.132	0.131	0.144	0.134	0.149	1.173	0.200	0.197	0.207	0.179	0.193
AGOVADM	0.000	0.001	0.001	0.000	0.000	0.000	0.001	0.001	0.001	0.003	1.080	0.001	0.001	0.001	0.001
AGOVEDUC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.000	1.035	0.000	0.000	0.000
AGOVHLTH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	1.082	0.000	0.000
AGOVSOC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	1.199	0.000
AGOVECN	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.001	1.155
CAGRI	0.100	0.059	0.359	0.062	0.056	0.057	0.065	0.056	0.055	0.070	0.073	0.081	0.077	0.071	0.072
CMIN	0.111	0.102	0.101	0.247	0.284	0.162	0.087	0.103	0.085	0.098	0.107	0.099	0.113	0.105	0.121
CFOODBEV	0.268	0.196	0.355	0.175	0.191	0.183	0.220	0.185	0.186	0.237	0.246	0.281	0.261	0.240	0.226
CMAN	1.145	1.009	1.010	1.303	0.905	1.304	0.891	1.102	0.856	1.002	1.121	1.009	1.134	1.064	1.187
CELECWAT	0.063	0.078	0.065	0.065	0.233	0.056	0.064	0.069	0.057	0.067	0.065	0.068	0.071	0.064	0.069
CCONS	0.034	0.040	0.032	0.030	0.107	0.355	0.054	0.038	0.059	0.044	0.045	0.033	0.037	0.039	0.159
CTRADCAT	0.329	0.286	0.356	0.333	0.273	0.330	0.285	0.314	0.264	0.311	0.336	0.328	0.345	0.328	0.349
CTRANCOM	0.309	0.419	0.296	0.293	0.270	0.281	0.342	0.395	0.284	0.304	0.326	0.314	0.332	0.348	0.364
CFINBUS	0.406	0.441	0.539	0.481	0.420	0.538	0.672	0.498	0.657	0.717	0.552	0.544	0.564	0.747	0.592
COTHSER	0.204	0.220	0.240	0.202	0.186	0.185	0.203	0.188	0.210	0.244	0.282	0.277	0.292	0.252	0.272
CGOVADM	0.000	0.001	0.001	0.000	0.000	0.000	0.001	0.001	0.001	0.003	0.080	0.001	0.001	0.001	0.001
CGOVEDUC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.000	0.035	0.000	0.000	0.000
CGOVHLTH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.082	0.000	0.000

Table 9 (continued)

	AAGRI	AMIN	AFOOD-BEV	AMAN	AELECWAT	ACONS	ATRAD-CAT	ATRAN-COM	AFIN-BUS	AOTH-SER	AGO-VADM	AGOVE-DUC	AGO-VHLTH	AGO-VSOC	AGO-VECN
CGOVSOC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.199	0.000
CGOVECN	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.002	0.001	0.152
LABHI	0.150	0.191	0.179	0.181	0.213	0.183	0.227	0.172	0.246	0.207	0.330	0.399	0.362	0.303	0.289
LABSK	0.201	0.178	0.192	0.182	0.183	0.161	0.244	0.212	0.195	0.221	0.438	0.549	0.487	0.378	0.364
LABLS	0.152	0.204	0.153	0.143	0.167	0.182	0.131	0.135	0.106	0.310	0.160	0.174	0.170	0.146	0.156
LABINF	0.037	0.029	0.034	0.031	0.029	0.049	0.054	0.041	0.035	0.040	0.027	0.027	0.028	0.029	0.031
CAP	0.772	0.780	0.718	0.645	0.796	0.641	0.788	0.751	0.818	0.702	0.609	0.626	0.580	0.640	0.603
TCM	0.297	0.249	0.316	0.306	0.236	0.304	0.232	0.263	0.216	0.259	0.284	0.272	0.291	0.271	0.292
ENTRP	0.703	0.710	0.654	0.588	0.725	0.583	0.718	0.683	0.745	0.640	0.554	0.570	0.528	0.583	0.549
HHD0	0.008	0.009	0.008	0.007	0.008	0.009	0.009	0.008	0.007	0.012	0.009	0.010	0.010	0.009	0.009
HHD1	0.009	0.009	0.008	0.008	0.009	0.009	0.009	0.008	0.007	0.013	0.010	0.011	0.010	0.009	0.009
HHD2	0.017	0.019	0.016	0.015	0.017	0.018	0.018	0.016	0.015	0.025	0.020	0.022	0.021	0.018	0.019
HHD3	0.021	0.023	0.020	0.019	0.021	0.022	0.022	0.020	0.019	0.030	0.024	0.028	0.026	0.023	0.023
HHD4	0.037	0.039	0.035	0.033	0.037	0.037	0.039	0.036	0.033	0.051	0.045	0.051	0.048	0.042	0.042
HHD5	0.050	0.053	0.048	0.045	0.050	0.050	0.053	0.049	0.046	0.068	0.064	0.074	0.068	0.059	0.058
HHD6	0.075	0.080	0.073	0.068	0.076	0.074	0.081	0.074	0.071	0.100	0.098	0.113	0.105	0.090	0.089
HHD7	0.110	0.118	0.108	0.101	0.114	0.107	0.121	0.110	0.109	0.143	0.149	0.174	0.159	0.138	0.135
HHD8	0.160	0.171	0.161	0.153	0.173	0.155	0.189	0.165	0.177	0.198	0.252	0.299	0.271	0.230	0.223
HHD91	0.125	0.135	0.127	0.122	0.139	0.122	0.151	0.130	0.146	0.151	0.202	0.240	0.218	0.185	0.178
HHD921	0.089	0.099	0.093	0.089	0.104	0.090	0.111	0.094	0.110	0.109	0.147	0.174	0.158	0.135	0.130
HHD922	0.197	0.207	0.192	0.177	0.213	0.177	0.217	0.197	0.222	0.203	0.215	0.239	0.220	0.212	0.202

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