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An Economy-Wide Impact Assessment of the Economic Infrastructure Investment Component of the Accelerated & Shared Growth Initiative (ASGISA)

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Rob Davies & Dirk Ernst van Seventer[1]

Abstract

We evaluate an infrastructure investment program for its impact on the South African economy with a comparative static economy-wide policy model. The infrastructure investment program can be associated with the Accelerated & Shared Growth Initiative for South Africa (ASGISA). In addition to the usual demand side injections, particular attention is paid to supply side impact of the investment program, productivity enhancement and skilled labour shortages. The national accounting consistency requirements of the modeled economy dampens the final impact of the demand injection considerably. Although productivity enhancement will have an additional positive impact this will be reduced by skilled labour shortages.

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1. Introduction

While it is difficult to pin down with any great accuracy what the Accelerated & Shared Growth Initiative for South Africa (ASGISA) means in terms of fiscal expenditures, it nevertheless suggests that there is a renewed urgency amongst South Africa's policy makers to redress the neglect of public sector infrastructure expenditure that occurred during the heyday of the Growth, Employment and Redistribution (GEAR) initiatives of the late 1990s and early years of the following decade. A number of additional concerns have been raised around financing of the initiative, skill shortages, productivity impacts and reduction of import content.

Policy makers are now keen to understand the economy-wide impact of the ASGISA and an assessment has been called for. The central part of ASGISA seems to be investment. This will impact on the economy through its demand and through its supply effects.

Macoeconomists would use some form of multiplier analysis to look at the demand impact. At the simplest level the macro multiplier can be written as

$$\frac{1}{(mps + mpm + t)}$$

In which *mps* is the marginal propensity to save, *mpm* the marginal propensity to import and *t* the tax rate. Coupled with the proposed investment of ΔI we could say ASGISA will raise demand by ΔY according to the following formulation:

(1) $$\Delta Y = \frac{1}{(mps + mpm + t)} \Delta I$$

However, macroeconomists would point out that this rise in demand will not necessarily translate into a rise in income. It assumes that there are no macroeconomic crowding-out effects. Indeed, some styles of macroeconomics would argue that raising demand in this way will have no effect on output, since they believe there is a completely inelastic aggregate supply curve. ASGISA from this perspective would simply cause inflation and change the composition of the economy towards the public sector. Clearly output in South Africa is not as constrained as this – there are unemployed resources, particularly labour, that could be brought into play to expand production. But equally clearly, aggregate supply is not perfectly

elastic, able to expand to meet any demand increase. Finite existing production capacity, import capacity and skills (amongst other) will constrain the economy's ability to grow.

The architects of ASGISA recognise this when they emphasise the capacity creating nature of the investment. It is not simply *any* investment but is targeted at specific sectors, particularly infrastructure, in order to try to ease bottlenecks.

Another simple analytical framework that can be considered for such an assessment is a SAM multiplier model. In the same way as the macromultiplier model, this framework typically multiplies the initial expenditure associated with ASGISA at an industry/commodity level up according to the following relation:

(2) $$\Delta X = \left(I - A\right)^{-1} \Delta I$$

In which ΔI is now a vector change in the demand for investment goods and ΔX is a vector of change industry/commodity outputs, which can be used to derive aggregate changes in income [ΔY of eqn (1) above]. This can potentially be counterbalanced by negative impact of various financing options such as higher taxes or higher private savings. Such an approach has been taken by McCord & van Seventer (2005) to evaluate the impact of expenditure *switching* of Public Works Programs from a machine based to a labour based approach. Their model is best suited for the evaluation of expenditure programs of limited size. However, ASGISA is more substantial than expenditure switching of about R300 million, as was the case in McCord & van Seventer (2005). In addition, the important potential broader impacts of ASGISA, such as raising productivity and reducing skill shortages, cannot be considered in such a simple first generation SAM based multiplier framework.

Policy makers are all too aware of unintentional counterbalancing effects of expansionary fiscal policy and would like to account for such eventualities in their design. We therefore employ a second generation Computable General Equilibrium (CGE) framework, which in its standard format accounts for a richer set of feedback effects due to flexible prices and substitution effects and in addition allows for further assumptions around productivity effects and skill shortages. We employ a simple comparative static framework similar to the standard IFPRI CGE model for South Africa (Thurlow & van Seventer, 2002, which was updated and applied recently by (Davies & van Seventer, 2005). The CGE framework is characterized by standard neoclassical attributes but allows for a range of structural features relevant to the South African economy. A full description of this type of model is found in Lofgren (2000).

Organisation: in the next section we introduce the preparation of the data for the ASGISA scenario, followed by a discussion of additional assumptions. Section 4 presents results of the various configurations.

2. Preparing the base data

In order to evaluate the economy-wide impact of ASGISA, the first question that needs to be tackled is how this initiative differs from a business as usual scenario.

We will be very modest in terms of what can reasonably be associated with the ASGISA program and are only considering the "economic infrastructure priorities" of ASGISA and ignore other priorities identified such as "meeting skills needs", "social security, health and education", "housing and neighbourhood development", "industrial development", "justice", "international relations, peace and security" and "public administration reform", all important areas but beyond the scope of our analysis here. The 2006 Budget documentation does not, however, offer specific numbers on "economic infrastructure priorities" apart from some broad categories such as road, rail, Gautrain and Industrial Development Zones. The total "additional" amount allocated under this chapter is about R13 billion over 3 years. Given the lack of detail in the budget, the next best way forward is to rely on earlier MTEF capital expenditure estimates of the November 2005 Medium Terms Budget Policy Statement (MTBPS).

The next table is reprinted from the MTBPS document (http://www.treasury.gov.za/). The first observation that can be made is that capital expenditure of the public sector, broadly defined here as the three tiers of government, development finance institutions (broadly the IDC, DBSA and LandBank) and State Owned Enterprises and Public Private Partnerships managed in the Treasury, is expected to jump by about 1% of GDP from a (recent) historical average of about 5.5%. For reasons of convenience we associate the 1% of GDP one-off increase in infrastructure expenditure with the ASGISA program.

Insert Table 1 somewhere over here

If the broad parameters of the infrastructure expansion in the context of ASGISA are acceptable, the next challenge is to fill in additional detail. According to the MTEF (2005, 36) the bulk of the expenditure is on infrastructure goods, including transport infrastructure, economic infrastructure, Industrial Development Zones and Research and Development Infrastructure, Municipal Infrastructure, Housing and infrastructure for Health, Justice and Correctional Services, while economic infrastructure by State Owned Enterprises is identified specifically to continue growing and an upward shift in the share of Public Private Partnerships is expected. The overall increase from 2005/06 to 2006/07, expressed as proportion of

GDP, is seen in the table to be almost like a once-off adjustment, as the proportion of capital expenditure to GDP is expected to remain constant in the next two years (2007/08 and 2008/09).

The Treasury's comments on these capital expenditure increases are not specific in terms of the kind of goods that will be purchased, a typical requirement to undertake a successful impact analysis. Expressing infrastructure investment demand in terms of goods and services purchased is possible if a distinction is made between the various asset types that are typically identified in the national accounts, such as building and construction, machinery and transport equipment. With that distinction it is relatively easy to identify the goods and services involved, a practice that is undertaken as part of the construction of the Supply-Use Tables for South Africa published by Stats SA. As a starting point we assume expenditure of building and construction works as typical for the expanded infrastructure investment program of ASGISA. An expenditure profile for this type of asset, which refers to residential and non-residential buildings as well as construction works, is available from Quantec's South African Standardised Industry Database (SASID, www.quantec.co.za).

This approach still lacks resolution and an improvement would be to make a distinction between investment in infrastructure by the public sector and public enterprises, with the former focusing exclusively on "building and construction works" while capital expenditure by public enterprises (essentially ESKOM and TransNet) would be the mix of asset types typical for the industries in which they operate. The latter is also available from the SASID data base if we assume that capital expenditure by these public enterprises is indeed representative for their sectors. Caution should be exercised here in that according the SARB Quarterly Bulletin (RB6088 and RB6089), Transnet only represents 25% of the capital expenditure in the transport sectors (but no detail on asset types is available).

Using Quantec's SASID data, the next table shows that the mix of capital expenditure by the electricity, water and transport sectors has altered somewhat over the recent years, perhaps reflecting changing priorities. In particular, the transport sector has shifted expenditure towards transport equipment, including rolling stock. Although this could reflect increased expenditure by private sector road transport operators, it could also be for increased expenditure by Spoornet and Portnet. At this stage we cannot verify details but assume that the 2004 expenditure pattern across asset types is broadly representative of the SOEs expanded infrastructure expenditure of ASGISA. Finally, we assume that expenditure by Public Private Partnerships and Extra-Budgetary Public Entities is solely on buildings and construction works asset type.

Insert Table 2 somewhere over here

Given these assumptions, we continue by presenting expenditure patterns for the two broad entities, i.e., public sector and state owned enterprises. In the next table it can be seen that given our assumption that

the three tiers of government (see first three rows of Table 1) only invest in the asset type building and construction works, the largest share of the expenditure is on building construction and civil engineering goods and services, with small shares on metal products and business services. Public Enterprises are assumed to invest in machinery and transport equipment as well as building and construction according to the proportions identified in the underlying Quantec data that is broadly consistent with the National Accounts. The distribution of this expenditure is across a wider range of goods and services as is shown in column 2 of the table, with machinery and equipment and motor vehicles now featuring at the expense of building construction.

Insert Table 3 somewhere over here

These expenditure patterns are applied to the overall value of 1% of GDP (in 2003 values as this is the latest year for which the underlying SAM is estimated) and the proportions are based on the MTEF shares shown in column 5, rows 10-15 of Table 1.

3. Economy-wide modeling assumptions

A number of critical assumptions need to be considered in order to get a realistic view on the economy-wide feedback of the expenditure program discussed in the previous section.

Demand side effects: representation of public investment

Firstly, in the SAM that underlies the model, investment from the public sector is added to that of the private sector. While we can simulate the demand side of government investment, we cannot simulate alternative financing arrangements directly. The model focuses on the real resource flows behind the investment, not on financial implications. The additional real resources for the investment have to be matched by increased real savings. This is the standard Keynesian story: a rise in investment must be matched by a rise in savings. The additional real savings can come from one or a combination of private, public and foreign savings. These can rise because the agents concerned save a higher proportion of a given income or because incomes rise. The financing arrangements might influence who does the saving, not the amount required.

It is best to think of the model as giving a real story that can be consistent with a number of different financing stories. We can simulate deficit financing by exogenously increasing the deficit by an appropriate amount. If we do this we have to keep the budget deficit (GSAV) fixed (and shock it) and allow either direct or indirect tax rates to adjust. Since our simulation is concerned with capital expenditure we do not have to worry about increasing tax rates as the current account of the public sector is not impacted, at least not directly.

Thus, although part of the expenditure program (60% in 2006/07, see rows 10-12 or column 5) is accounted for by the three tiers of government and it is tempting to consider increases in direct and / or indirect taxes or increases in the budget deficit as the most likely financing options, the underlying SAM reports on the deficit on the current account of the public sector and *not* on the public sector borrowing requirement (PSBR). Therefore, in our modeled economy, capital expenditures by the public sector cannot be financed by means of higher taxation. The only other finance options available is by issuing government bonds, which implies that private savings have to be raised. In reality this typically means that enterprise savings will increase and the distribution of dividend income to households, with its typical distribution characteristics will decline.

Supply side effects: capital expansion

Exogenous injections of investment expand productive capacity as well as raise demand. We have added to the stock of capital, in particular infrastructure, which shifts of the production function outwards, increasing supply. We can simulate this in a comparative static framework by exogenously increasing capital stocks in targeted sectors.

In effect, we assume that the supply impacts work themselves out over the modeling period. Based on the proportions of Table 1 and the sectoral weights in investment from the Quantec industry database we calculate that 60% of the increase in capital expenditure is accounted for by the sector "government services", while the rest is distributed across the SOE sectors electricity and transport in the proportions 17.1% and 22.9%. Although there will be depreciation over the period, we assume that there will also be 'normal' replacement investment so that the ASGISA figures represent a net addition to the sectoral capital stocks. These are shown in the table.

This approach requires careful understanding of the purpose of comparative statics. In the real world, as the capital stock of the targeted sectors increases, there may be simultaneous changes in the capital of other sectors, for reasons not related to ASGISA. There may also be changes in the size and composition of the labour force. We do not simulate these because we want to focus on the impact that ASGISA will have, not make a forecast of what may or may not happen in the economy due to other events. However, if we think (as is probably the case) that the ASGISA investment will induce ('crowd-in') investment in other sectors, we should model it. Unfortunately there is no information as to what this likely crowding-in effect will be. It is plausible that ASGISA induces a change in the composition of private investment rather than an increase in the amount (firms change investment plans, shifting proposed investment to piggy back on ASGISA growth sectors). We do not know about this and therefore assume that there is no induced investment. If we had information on this we could model it as further exogenous increases in

capital stocks. Further research into these private responses to public investment will be important if we wish to understand the full effects of ASGISA.

Supply side effects: productivity growth

Since it is the purpose of additional capital expenditure associated with ASGISA to make the South African economy more competitive, it makes sense to consider assumptions around efficiency increases. It can be shown (see Appendix) that under constant returns to scale, efficiency increases in an industry's average cost function is equivalent to increasing the productivity scale factor of the CES production functions employed in our modeling framework. Most of the capital expenditure has an infrastructure theme and we therefore evaluate the impact of a productivity increase in the transport services sector. Without reference to particular studies in this regard we assume that this sector will experience a productivity increase of 5%.

Skills Shortages

Policy makers are aware of critical shortages of skilled labour to drive this program. In general, South Africa's growth prospects are seen to be held back by skill shortages. A number of initiatives are currently underway to address these problems and it makes sense to evaluate the impact of addressing the skill shortage on the impact of the capital expenditure program. We do this by assuming one scenario with and one without fixed high skilled labour supply. The latter typically drives up wages in those sectors most impacted by the demand and may well result in other sectors having to release skilled labour, thereby reducing growth elsewhere. Unconstrained skilled labour would therefore typically have a greater more positive impact from the injections such as those evaluated here.

Other ASGISA elements

Concern has been raised by policy makers (http://www.miningweekly.co.za/?show=79388) about the relatively high import content of some commodities that are characteristic of capital expenditure. In particular, reference is made to the import content of machinery. The underlying SAM data suggests that about 60% of the local demand for machinery is imported. Although, there are various ways of promoting local manufacturing which has wider implications beyond the ASGISA capital expenditure program, we ignore these possibilities for reasons of convenience. Moreover, there are a range of important youth and gender issues associated with ASGISA (see statements by the vice-president: http://allafrica.com/stories/200601180589.htm), but we take no notice of these issues due to lack of data in the underlying SAM. Similarly, we also overlook the possible impact of switching part of the capital expenditure from "regular" machine based to labour based expenditure under the Expanded Public Works Programs (EPWP) at this stage.

Closures

Macroeconomic adjustments (closures) are the same for all simulations. We assume that the government budget deficit and real government current consumption are both fixed. To ensure this revenue is adjusted by a uniform percentage change to income tax rates across all households and enterprise. The current account on the balance of payments is fixed, and adjustment is through the exchange rate which is flexible. Investment is fixed, with savings adjusting where necessary though a change in the marginal propensity to save of enterprises.

The fixed budget deficit could be interpreted as assuming that ASGISA is not financed through a larger budget deficit. This is appropriate, since capital expenditure is not part of current spending. The model does not address the source of finance for the ASGISA.

Assuming a fixed current account deficit effectively means that ASGISA is not based on an inflow of foreign resources. If it is intended that there will be such an inflow, either through aid or foreign investment, it would be possible to adjust the fixed foreign deficit the anticipated amount.

The assumption of investment driven savings is in part necessitated by the desire to *impose* the ASGISA investment on our modeled economy (if we did not do this, ASGISA would simply crowd out current investment as the level of investment adjusted to match the exogenous level of savings).

Taken as a package, these three closures essentially place the burden of releasing the resources for ASGISA on the private sector. This does not mean that the private sector finances or undertakes the investment. Rather, we are referring here to the real resource flows needed to accommodate ASGISA in the economy. This is an important issue as ASGISA will lay claim to a large amount of resources. These have to come from somewhere. If we think about the standard national income balance, when we raise investment either savings or income has to rise. Our assumptions imply that it is savings, and more specifically private sector savings, that goes up.

How does this tally with the view that the resources for ASGISA will come from growth? We deliberately do not model this because we think that the growth dividend will come with a lag, and that the resources have to be released before the dividend is realised. The growth dividend provides the rationale for ASGISA by holding out the hope that diversion of resources away from current uses now – and most importantly current consumption – will lead to a better future. But it would be wrong, and politically would create hard-to-manage short-run expectations, to suggest that it has no real immediate cost.

We assume that there are no constraints on labour supplies of all skill types. In the last simulation we consider the effects of a skills shortage. However, we prefer to assume perfectly elastic supplies of labour

because it gives an upper bound on possible employment creation. Those who do not like the assumption should interpret our results as showing what the impact will be on labour demand rather than employment. We also assume that capital is sector specific and operates at full capacity.

Summary of scenarios

We can now summarise our scenarios as follows:

1. Supply expansion only, without skill constraint
2. Supply + demand expansion without skill constraint
3. Supply + demand expansion + productivity increase in the transport sector without skill constraint
4. Supply + demand expansion + productivity increase in the transport sector under skill constraint

4. Results

We present results for the sequence of scenarios noted above.

Scenario 1: Supply expansion, without skill constraint

We start with a supply expansion without skill constraint.

Description and Motivation

ASGISA injects capital into three targeted sectors, “electricity, gas and water”, “transport” and “government services”. One of the main motivations for this is to remove some bottlenecks or constraints on growth. This is a supply side effect. Our first simulation therefore attempts to look at pure supply effects. It does so by exogenously increasing the capital stock in the targeted sectors.

A partial equilibrium approach would look only at the targeted sectors and see how the injection of capital raises capacity and therefore supply, employment, etc in those sectors. This probably captures much of the thinking of policy makers. They see the direct impact and assume that there are no countervailing impacts. In an economy-wide framework, even though we focus on supply effects only, we have to think about knock-on effects for other factors of production, in other sectors and about macroeconomic constraints.

Additional capital will increase labour demand. With the assumption of perfectly elastic supplies of labour, employment rises. Output of targetted sectors will rise and the price of output should fall. At the macro level GDP must rise since more resources are being drawn into use. Import demand increases and exports may rise on the back of expanded supply. Because of fixed foreign savings, imports may have to rise further depending on the net effect. Sectors supplying the target industries are likely to see an increase in demand for their product, such as rubber.

Results:

Table 4 shows some selected impacts on the targeted sectors. We run through each row in turn.
As shown in Row 1, the capital stock in each sector rises according to the shock we have imposed.
In our standard set-up this would give rise to a paradoxical result (certainly against the intuition explained above). There would be a fall in the demand for labour in the three targeted sectors as the increase in capital stock leads to a large fall in the price of capital in those sectors (Row 3). This has to happen in the neoclassical set-up of the model, since capital is factor specific and fully employed. The price of labour is fixed, in accordance with the assumption of perfectly elastic supply. There is therefore a substitution away from labour towards capital.

Insert Table 4 somewhere over here

This goes against all beliefs that sensible people might hold. How is it possible that a large injection of capital into a sector could not lead to a rise in employment? Those beliefs are based on a view that capital and labour are complementary. We see this often in arguments like "Each job in the formal sector costs R300 000 to create. Therefore if we invested R3bn we would create 10 000 jobs." This fixity of capital / labour ratios might be plausible in the short run. In the long run however, the investment affects the relative prices of capital and labour. Firms will adjust to these new price ratios and change their decisions about capital intensity. In its standard set-up, the model would capture these long run effects.

However, we can simulate a protection of labour intensity in these target sectors, thereby simulating the fact that ASGISA is trying to promote labour intensity, and prevent shifts in factor intensity in favour of capital. In terms of the model, we can, in principle, fix either the quantity of labour (in the sector or in aggregate) or we can set nominal wage rates, not both. This is reasonably like the real world.
Normally in the model this choice is made as a blanket choice over the whole economy. But it is possible to fix employment within one sector (or group of sectors), while still allowing it to vary in all other sectors. We do have to allow the wage in the fixed sectors to vary though.

Sector wages are made up of the national average wage (for that type of labour) modified by a sector specific wage differential. If we want to fix the employment in the sector (we can fix it so there is no fall at all or we could even add to it by an exogenous amount), the best thing is to allow this wage differential to vary.

If we now add to the capital stock in these sectors, the differential falls – i.e. wages in the sector go down. The logic is obvious, there is an injection of capital, which cheapens capital and firms would like to

subsitute away from labour. But we do not let them. However, they continue to maximise profit and will employ the same amount of labour as before only if it is cheaper.

This may makes sense within the context of public works type programmes. Essentially there the decision about employment is not being made on business grounds , i.e., not profit maximising. If you were doing it via profit maximising firms, you would have to subsidise wages to get the firms to take on the additional workers. The fall in wages that the model generates shows how much we would have to subsidise by.

Nevertheless, it is relevant to ask whether we expect the large amounts of capital that the Government plans injecting into the targeted sectors under ASGISA to leave their capital intensity unaffected? It is likely to cheapen capital in those sectors (since supply has risen) and this should push the sectors to become more capital intensive than previ ously.

The ASGISA thinking is that injecting capital creates jobs in the targeted sectors. But this is only true on the investment projects themselves. The sectors we work with are aggregations of numerous sub-sectors. The ASGISA investment is probably targeted at one of these subsectors. But it will have an impact on the viability of all subsectors. Think for example of transport. If the ASGISA project is the Gautrain, there may well be jobs created on the Gautrain. But at the same time other forms of transport lose out – they have to compete with Gautrain. So jobs may be lost in other parts of the transport sector. The model could be interpreted as reflecting this.

Unfortunately with the way the model and data are set up at the moment, the fixed employment applies across the whole sector, not just to the project part. This misses the impact mentioned above – that the project output competes with 'normal' outputs in the sector (Gautrain displacing other forms of transport). It might be better to change the underlying SAM so as to split the targetted sectors into a project component and a normal component and have some aggregation of the outputs of the two, so they are not perfect substitutes. Then we can inject the capital and fix the employment in the project sub-sector, leaving the other alone.

Because the ASGISA share of capital stock in the target sectors (electricity, transport and government services) is limited, we can safely ignore the above described protection of labour intensity in the target sectors and assume that the same market adjustment rules apply after the investment has taken place.

As mentioned above, another issue is that there may be 'crowding-in' but it will be in different sectors. Our model does not show this – since capital in other sectors is fixed. Lack of specific investment functions, in which such 'crowding-in' is described (see Gibson & van Seventer, 199?) requires us to tell this explicitly

to the model. If we want to model this we need information about what the sector specific crowding-in effects are.

Output in all three sectors rises, but by relatively small amounts. This is not surprising: the capital injection is small relative to their initial capital stocks, and therefore has insignificant impacts on production. Prices fall (Row 6). This is one of the main microeconomic channels through which the ASGISA investment will impact on other sectors. The fact that the falls are slight should lead us to anticipate negligible economy-wide effects *through this channel.*

One result that highlights something that we probably would not think of in a partial equilibrium approach is that exports of the sectors rise (Row 6) . The percentages do not matter here – they appear to be large because the sectors in-fact export very little. But the qualitative result is interesting. One response to ASGISA might be to supply more to foreign markets.

Macroeconomic effects

Column 2 of Table 5 shows the main macroeconomic effects (with the first column showing the base levels in 2003 Rbillion). GDP market prices rises by 0.07%. This is largely driven by rising consumption which rises by 0.11% due to the real household income effect following the price decreases discussed above. The reason for this increase can thus be traced back in part to higher real household incomes. However, in addition it can also be traced back to reduced tax rates (with GDP rising, the tax base rises, but with fixed government consumption and savings, revenue has to remain the same so tax rates have to come down.[2] Finally, recall that in this simulation the demand effects of the additional investment are still excluded, as this is part of the second scenario.

Insert Table 5 somewhere over here

Economy-wide sector impacts

Targeted sectors may impact on other sectors through either forward or backward linkages. The results are shown in column 2 of Table 6 (with the first column showing the base levels in 2003 Rbillion). The forward linkage channel operates through reduced prices of the output of targeted sectors leading to reduced costs on intermediate inputs in purchasing sectors. This is a price effect and will stimulate output on those sectors only in so far as the reduced costs allow a fall in the price of their output which may stimulate demand. Both “Electricity” and “Transport” are widely used as intermediates, so there are numerous forward linkages. However, since, as we have seen, the reduction in the input prices is small,

[2] We considered a flexible budget deficit and keep tax rates fixed. This may be more in line with current fiscal practices. But it doesn’t effect the scenarios directly as the main adjustment goes through enterprise savings. Sensitivity analysis revealed little or no impact.

this effect is small. The largest increase in marketed output is 0.4%, while in most sectors it is not significantly different from zero.

Insert Table 6 somewhere over here

The backward linkage channel operates because the targeted sectors increase their purchases of intermediate inputs from other sectors. Again the effects are small. Besides the target sectors themselves, the only other sector that stands out is rubber product, where a 0.2% increase is expected. This suggest possible incorrect bias of the assumed investment based on industry averages in the direction of investment in road transport, which is not necessarily what ASGISA is about and highlights the importance of bottom-up data inputs that are tailored to the issue at hand.

Employment impacts

Without making any adjustments to the model set-up that allow for special employment arrangements in the government expenditure program, in construction as well as the targeted sectors (electricity, transport services and government services), we proceed by presenting the results for employment in the next table. As before, results are shown for all scenarios, here we're only interested in the second column as it represents the first scenario, focusing on the supply expansion only.

Insert Table 7 somewhere over here

Note that we assume that labour of all skills is plentiful available, even in the targeted sectors. For good measure, we report in the first row on the percentage increase in the demand for capital. It can be seen that this is fixed at 0.49% for all scenarios, i.e., an increase in the capital stock of 1% of GDP translates into a 0.5% increase. As a matter of interest, the marginal capital-output ratio is therefore about 2.

In terms of the first scenario, the increase in semi-skilled labour is 0.07%, which is roughly equal to about 3,000 workers. The total increase associated with the supply increase only is expected to be about 4,000 full time equivalents. However, if the expenditure would not be maintained the next period, employment would revert back to the base levels shown in the first column

Scenario 2: Supply + demand expansion, without skill constraint

Next, we add the demand side stimulus to the supply side expansion of the first scenario described above. The demand-side stimulus is typically the one that is most often referred to in impact analyses that employ input-output or first generation SAM based multiplier models. A useful benchmark is that the multiplier of a typical demand side injection is round about 1.2 – 1.3. However, as can be seen in Table 5, the increase in GDP rises from 0.07% (only accounting for the supply stimulus) to 0.32% (accounting for

the supply *and* demand stimulus) of GDP when comparing scenario 1 and 2, while the initial increase in investment demand is a full 1% of GDP. Our challenge here is trying to find an explanation for this results.

We described earlier that that the increase in investment demand is assumed to be financed out of enterprise savings. Not shown here is that the enterprise savings *rate* increases by about 9% from 42% to about 46%. What is left for distribution to households by enterprises after savings are accounted for will clearly be less. Consequently, household income and thus household expenditure will be lower. This is confirmed in the second entry of Table 5 where it can be seen that household consumption declines by 1.2%. Since the decline in consumption affects those households that are recipients of unearned income (from enterprises) more than households that receive income from labour, this will impact negatively on those sectors that supply goods and services that are typically consumed by these households. In particular this applies to demand for goods and services from food, beverage, clothing, furniture, and some of the services, as can be seen in Table 6.

Nevertheless, the initial investment demand stimulus benefits those industries that produce directly (see Table 3) and indirectly the relevant investment goods. The main recipients are, amongst others, construction and related industries such as metal products and wood products, but also transport equipment, plastic and glass products and electrical machinery.

Investment draws in imports (see row 7 of Table 5) and, given the assumed fixed current account on the balance of payment, exports need to rise in order to achieve this. As a result the exchange rate has to depreciate. The model suggests (see row 9 of Table 5) that the exchange rate depreciation is about 0.57% in the second scenario, up from 0.01% in the first scenario.

The construction bias in the initial expenditure has a major impact on the demand for low skilled labour, as can be seen in Table 7, with demand for more skilled labour increasing to a lesser extent. Employment in the construction is reported (but not shown here) to increase by more than 20% across all skill levels but along with changes in output, employment levels are lower than the base for a number of sectors including, as before, food, beverage, clothing, furniture, and some of the services.

Insert Table 8 somewhere over here

The impact on household income is less clear. In Table 8 we report on household income for the 10 income deciles, with the top decile broken down into further detail, one of 5% and 4 of 1.25%. With higher enterprise savings, unearned income distributed to households will decline and as a results consumption will be lower, as was shown in Table 5. Interestingly, due to the distribution of unearned income, top income earning households are more exposed to this negative impact.

Scenario 3: Supply + demand expansion + productivity increase, without skill constraint

Introducing productivity gains is the good new story of this paper. Remember that we raised multifactor productivity by 5% and that only for the transport sector. The impact on GDP is significant , almost double compared to the previous scenario, i.e., without the productivity increase. Nevertheless, the impact is still only 0.6% of GDP. The negative impact on consumption is now also less given the higher incomes. The productivity effect works mainly through exports, as producers are now more competitive. The exchange rate does not depreciate as much as in the previous scenario but increased income still draws in imports. The sectors that will benefit most from the increase in productivity in the transport sector are those that produce for the export and consumption markets, not those that produce for investment demand (see Table 6). The latter typically remain stationary relative to the previous scenario while food, beverage, clothing, furniture, and some of the services typically expand. Employment gains of productivity increases are distributed differently with demand for semi and highly skilled labour increasing relatively more (see Table 7), but in terms of income distribution the gains are more evenly shared (see Table 8), with some low income households not improving their income position, while high income households still suffer albeit to a lesser extent.

Scenario 4: Supply + demand expansion + productivity increase under skill constraint

We end our analysis with a scenarios that builds on the previous one in which we combined supply, demand and productivity increases under unlimited supply of labour. Imposing a constraint on the supply of highly skilled labour will change the impacts considerably, as can be seen in the last column of Table 5. The impact on GDP reduces from 0.64% to 0.55%. At the macro level, the additional impacts of the skill constraint is distributed fairly evenly, without any particular variable bearing the brunt. At the sector level, it would appear from Table 6 that services sectors are mostly affected by the constraint on high skilled labour. A number of channels are at work here: not only is a sector that uses highly skilled labour held back more in its supply of output, their prices will rise, making their goods and services lose market share vis a vis goods and services of other sectors and households more likely receiving less income from high skilled labour (see the last column of Table 8) typically demand goods and especially services that are produced by these sectors. The impact on the demand for labour is shown in the last column of Table 7. As expected, employment of highly skilled labour is fixed by assumption, but other skilled labour is also negatively impacted. The supply constraint of highly skilled labour costs about 3 000 full time equivalents of other semi and low skilled workers, even though these are available for work.

5. Conclusions

It is important to note that the results are not forecasts of what may or may not happen to the South African economy. At best, the results give a sense of direction off a comparative static benchmark.

Moreover, we have been very modest in terms of what can reasonably be associated with the ASGISA program so as to avoid raising unwarranted expectations. At best we are considering the "economic infrastructure priorities" of ASGISA and ignore other priorities identified such as "meeting skills needs", "social security, health and education", "housing and neighbourhood development", "industrial development", "justice", "international relations, peace and security" and "public administration reform", all important areas but beyond the scope of our analysis here. The Budget documentation does not, however, offer any specific numbers on "economic infrastructure priorities" apart from some broad categories such as road, rail, Gautrain and Industrial Development Zones. The total "additional" amount allocated under this chapter is about R13 billion over 3 years, even less than what we have injected into our modeled economy which we took to be 1% of GDP. Given the lack of detail in the budget, the next best way forward is to rely on the earlier MTEF capital expenditure estimates of the November 2005 Medium Terms Budget Policy Statement (MTBPS) and this is what we have attempted in this paper.

In terms of our quantitative analysis, the innovation here is that, compared to traditional impact analysis with Input-Output and first generation SAM based models, we have accounted for a number of channels through which an economic infrastructure investment program such as the one associated with ASGISA may play itself out in the South African economy. In particular we account for:

1) a combination of economy-wide price, quantity and substitution effects while the standard analysis only considers quantity effects
2) specific finance decisions, in particular we consider a consistent economy-wide accounting framework that forces us to think about the inevitability that somewhere someone will have to pay for the outlays. Although we made it clear that since ASGISA is about investment expenditure and the public sector's current account is not impacted (at least not directly), the savings-investment balance cannot be avoided. If foreign savings are not an option, the only remaining adjustment mechanism is domestic savings. We decided that it made most sense to opt for enterprise savings but in the end it doesn't really matter all that much.
3) Although we use a comparative static framework, we incorporate supply as well as demand considerations, while traditional impact analysis only considers the latter.
4) Productivity increases are incorporated which shifts the production frontiers out for those sectors that are to benefit most from the investment. In this case we assume a hypothetical productivity increase in the transport services sector.
5) Much has been said about shortages of highly skilled labour. While we ignore this problem initially, we return to it in our last scenario and it does appear to make a difference, in particular for those activities that are know for their high skilled labour requirements such as medical services.

On balance, we find that the impact of ASGISA is therefore not likely to be as large as policy makers would have hoped for. The reasons are by now clear: simple multiplier analysis ignores the hard realities

of national accounting consistency. In the end, our modeled impact of the investment program is then not more than an exercise in compositional shifts. What does get the economy going is increases in productivity. We've been fairly modest by assuming productivity increases in one sector only. Whether our assumption is on target remains to be seen. Only bottom-up sector specific analysis of the impact of investment programs on productivity will be able to shed light on this, but the pay-off may well be worth it.

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Tables

Table 1: 2006 MTEF Capital Expenditure Estimates (R million, current prices)

		1	2	3	4	5	6	7
					Estimate	Medium-Term Estimate		
	Absolute values	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09
1	National Departments	8,647	9,623	10,815	12,740	16,024	18,945	23,486
2	Provincial Departments	12,976	16,380	18,024	21,025	27,755	30,561	33,976
3	Municipalities	13,100	16,687	17,053	20,109	22,965	25,346	28,166
4	Public Private Partnerships	849	1,552	1,106	1,635	5,631	7,250	5,372
5	Extra-Budgetary Public Entities	2,854	3,053	3,470	3,711	4,116	4,521	4,927
6	Non-Financial Public Enterprises	26,803	21,375	22,145	27,080	34,735	38,350	39,842
7	Total	65,229	68,670	72,613	86,300	111,226	124,973	135,769
8	Percentage of GDP	5.5%	5.4%	5.2%	5.6%	6.6%	6.7%	6.7%
9	GDP	1,193,771	1,277,029	1,405,529	1,542,529	1,693,714	1,856,663	2,033,343
	Shares	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09
10	National Departments	13.3%	14.0%	14.9%	14.8%	14.4%	15.2%	17.3%
11	Provincial Departments	19.9%	23.9%	24.8%	24.4%	25.0%	24.5%	25.0%
12	Municipalities	20.1%	24.3%	23.5%	23.3%	20.6%	20.3%	20.7%
13	Public Private Partnerships	1.3%	2.3%	1.5%	1.9%	5.1%	5.8%	4.0%
14	Extra-Budgetary Public Entities	4.4%	4.4%	4.8%	4.3%	3.7%	3.6%	3.6%
15	Non-Financial Public Enterprises	41.1%	31.1%	30.5%	31.4%	31.2%	30.7%	29.3%

Source: Treasury 2005

Table 2: Capital expenditure shares across asset types for selected sectors (2004)

		Y1211: Buildings and construction works	Y1212: Machinery and other equipment	Y1213: Transport equipment
Electricity & water	2002	72.5%	24.3%	3.2%
	2003	72.0%	24.6%	3.4%
	2004	72.3%	22.2%	5.4%
Transport & storage	2002	14.8%	54.8%	30.3%
	2003	14.6%	51.3%	34.1%
	2004	19.3%	38.3%	42.4%
SOEs	2002	35.4%	44.0%	20.6%
	2003	37.1%	40.8%	22.1%
	2004	42.0%	31.4%	26.6%

Source: Quantec

Table 3: Capital expenditure patterns for public sector and public enterprises, 2004

	1 Government	2 Public Enterprises
Wood and wood products [321-322]		0.1%
Rubber products [337]		0.2%
Non-metallic minerals [342]	0.1%	0.1%
Metal products excluding machinery [353-355]	4.4%	3.7%
Machinery and equipment [356-359]		8.2%
Electrical machinery and apparatus [361-366]		2.0%
Television, radio and communication equipment [371-373]		1.5%
Motor vehicles, parts and accessories [381-383]		20.9%
Other transport equipment [384-387]		2.1%
Furniture [391]		0.3%
Other manufacturing [392-393]		2.3%
Building construction [51] & civ eng [52-53]	91.5%	50.1%
Wholesale and retail trade [61-63]	0.3%	4.6%
Transport and storage [71-74]	0.0%	0.2%
Business services [83-88]	3.6%	3.7%
Total	100.0%	100.0%

Source: Treasury 2005, Quantec and own calculations

Note: Public Enterprises includes extra budgetary Public Entities and Public Private Partnerships

Table 4: Impact on target sectors (% change)

	Description	Model Abbreviation	Electricity	Transport	Government Services
1	Sector capital stock	QF(CAP,A)	2.1	0.7	1.3
2	Sector labour demand	QF(LAB,A)	0	0	0
3	Sector price of capital	WFA(CAP,A)	-19.7	-1.5	-23.9
4	Activity level	QA(A)	1.2	0.4	0.2
5	Activity price	PA(A)	-10.3	-0.2	-15.1
6	Exports	QE(C)	41.7	1.6	0.4

Source: model results

Table 5: Macro variables, % change in constant prices

			Scen 1	Scen 2	Scen 3	Scen 4
		BASE	PINVCAP	PINV2	PINVPROD	PINVSK
		Rbn	% change	% change	% change	% change
1 Total Absorption	ABSORP	1,231	0.07	0.33	0.65	0.56
2 Private consumption	PRVCON	786	0.11	-1.22	-0.71	-0.86
3 Fixed investment	FIXINV	200		6.80	6.80	6.80
4 Change in inventories	DSTOCK	5				
5 Government consumption	GOVCON	239				
6 Exports	EXPORTS	340	0.05	0.31	0.60	0.53
7 Imports	IMPORTS	-319	0.06	0.33	0.63	0.56
8 GDP at market prices	GDPMP	1,251	0.07	0.32	0.64	0.55
9 Exchange rate (LCU per FCU)	EXRXP	1.00	0.01	0.57	0.35	0.33

Source: model results, LCU is local currency unit, FCU is foreign currency unit

Table 6: Impact on real output of all sectors (% change in QAXP level of dom activity)

		BASE 1	Scen 1 PINVCAP 2	Scen 2 PINV2 3	Scen 3 PINVPROD 4	Scen 4 PINVSK 5
1.	Agriculture, forestry & fishing	81.5	0.00	0.10	0.10	0.00
2.	Coal mining	30.8	0.00	0.10	0.20	0.20
3.	Gold & uranium ore mining	35.5	0.00	0.10	0.10	0.10
4.	Other mining	86.7	0.00	0.20	0.20	0.20
5.	Food	108.2	0.00	-0.20	-0.10	-0.20
6.	Beverages & tobacco	37.6	0.00	-0.10	-0.10	-0.10
7.	Textiles	19.9	0.00	0.00	0.00	-0.10
8.	Wearing apparel	16.9	0.10	-0.50	-0.30	-0.50
9.	Leather & leather products	4.6	0.00	0.50	0.30	0.20
10.	Footwear	3.7	0.00	0.10	-0.10	-0.20
11.	Wood & wood products	18.5	0.00	1.10	1.10	1.10
12.	Paper & paper products	38.8	0.00	0.30	0.30	0.10
13.	Printing, publishing & recorded media	18	0.10	-0.20	-0.10	-0.30
14.	Coke & refined petroleum products	65.2	0.00	0.10	0.30	0.30
15.	Basic chemicals	55.7	0.00	0.50	0.50	0.40
16.	Other chemicals & man-made fibres	68.7	0.10	-0.20	-0.10	-0.30
17.	Rubber products	9.3	0.20	-0.10	0.40	0.30
18.	Plastic products	24.5	0.00	0.90	0.90	0.70
19.	Glass & glass products	4.7	0.00	0.60	0.60	0.50
20.	Non-metallic minerals	18.4	0.00	4.90	5.10	5.10
21.	Basic iron & steel	74.8	0.00	0.10	0.10	0.10
22.	Basic non-ferrous metals	28.9	0.00	0.10	0.00	0.00
23.	Metal products excluding machinery	46.1	0.10	2.60	2.50	2.40
24.	Machinery & equipment	40.5	0.00	0.20	0.20	0.10
25.	Electrical machinery	26.9	0.00	2.50	2.60	2.50
26.	TV, radio & communication equipment	6.6	0.00	0.30	0.30	0.10
27.	Professional & scientific equipment	3.8	0.00	-0.10	-0.20	-0.40
28.	Motor vehicles, parts & accessories	111.1	0.00	0.20	0.20	0.10
29.	Other transport equipment	10	0.10	0.50	0.50	0.20
30.	Furniture	10.9	0.10	-0.30	-0.30	-0.40
31.	Other industries	38.6	0.00	-0.20	-0.10	-0.20
32.	Electricity, gas & steam	41.2	0.30	0.30	0.50	0.40
33.	Water supply	14	0.10	-0.10	0.20	0.10
34.	Building construction & civil engineering	110.7	0.00	11.10	11.20	11.20
35.	Wholesale & retail trade	278.9	0.10	0.20	0.40	0.30
36.	Catering & accommodation services	29.8	0.10	-0.20	-0.20	-0.30
37.	Transport & storage	162.2	0.40	0.30	3.50	3.40
38.	Communication	106.2	0.10	-0.10	0.10	0.00
39.	Finance & insurance	160.6	0.10	0.00	0.20	0.10
40.	Business services	249.3	0.10	-0.10	0.10	0.00
41.	Medical and other services	61.8	0.10	-0.90	-0.60	-0.80
42.	Other services	74	0.10	-0.80	-0.40	-0.70
43.	Government services	262.1	0.00	0.00	0.00	0.00

Source: model results

Table 7: Impact on factors of production (% change in QFSP level of quantity of factor supply)

	% increase	BASE 1	Scen 1 PINVCAP 2	Scen 2 PINV2 3	Scen 3 PINVPROD 4	Scen 4 PINVSK 5
1.	Capital		0.49	0.49	0.49	0.49
2.	Low skilled		0.07	1.63	1.83	1.77
3.	Semi skilled		0.05	0.31	0.57	0.54
4.	Highly skilled		-0.02	0.07	0.31	
	Absolute increase ('000)					
5.	Low skilled	2,566	3	57	65	63
6.	Semi skilled	3,537	2	11	20	19
7.	Highly skilled	3,416	0	1	4	0
8.	Total	8,377	4	69	89	81

Source: model results

Table 8: Impact on household income (% change in YIXP)

	BASE 1	Scen 1 PINVCAP 2	Scen 2 PINV2 3	Scen 3 PINVPROD 4	Scen 4 PINVSK 5
1. HHD1	15.84	0.02	0.00	0.13	0.08
2. HHD2	21.98	0.02	-0.04	0.07	0.01
3. HHD3	29.31	0.03	-0.07	0.07	0.01
4. HHD4	38.79	0.03	-0.36	-0.18	-0.27
5. HHD5	50.35	0.03	-0.51	-0.28	-0.36
6. HHD6	71.57	0.03	-0.62	-0.37	-0.43
7. HHD7	103.7	0.03	-0.82	-0.53	-0.58
8. HHD8	160.98	0.03	-1.05	-0.72	-0.77
9. HHD91	127.48	0.02	-0.90	-0.59	-0.56
10. HHD921	42.77	0.02	-0.96	-0.64	-0.57
11. HHD922	50.01	0.00	-0.44	-0.21	-0.05
12. HHD923	57.83	0.03	-1.41	-1.00	-0.98
13. HHD924	114.03	0.04	-1.84	-1.36	-1.40

Source: model results