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South Africa – how do we become a BRIC?

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1. Introduction

In a recent tralac Trade Brief, Sandrey (2011) examined how South Africa measured against some of the general criteria associated with the so-called BRIC economies of Brazil, Russia, India and China. It is popularly thought that high growth rates are a precursor to membership, but this is patently not the case. China and India are global growth stars in recent years, but Russia's inconsistent and erratic growth path has been poor while both Brazil and South Africa do no better than sit around the middle of global performers at best. Again, China's oft-quoted stellar export performance is well known; India's export performance is admirable; Brazil has at best treaded water; while South Africa is slowly declining in global significance.

The overall generalisation is made from the study that South Africa does not 'measure up' in terms of economic size, but fits the middle patterns of Gross Domestic Product (GDP) growth in recent years where the perceived concept of the BRICs dynamic GDP growth is biased due to the spectacular growth of China and India. South Africa also does not 'measure up' in terms of trade levels and its performance has been below that of the other members. Overall, the BRIC 'club' is not one where South Africa necessarily belongs 'as of right' given the measures we have assessed membership against. But then, perhaps, Russia does not either.

The objective for this paper is to assess what South Africa may need to do to genuinely claim membership of this exalted club. To do this we use the Global Trade Analysis Project (GTAP) database and associated computer model to illustrate the importance of increased Total Factor Productivity (TFP) in the South African economy and the impact it has upon both GDP growth rates and trade performance until 2020 from a base year of 2007. We do this by treating TFP as exogenous (i.e. adjusted from outside the model) and re-running simulations to ascertain the impacts upon both growth rates and trade performance.

Why TFP?

In its classical form an economy is driven by production or total output, and this is a function of the land, labour and capital inputs used. This total output can be increased by (a) increasing the inputs or by (b) increasing the efficiency by which these inputs are combined. Both inputs and output can, in most cases, be measured, therefore TFP becomes somewhat of a residual and slightly mysterious value that is hard to actually quantify. It can range from technology as such to more fundamental factors such as the knowledge and therefore performance of the workers in the form of human capita. As succinctly stated by McCarthy (2005):

Economic activity can be thought of as the sum of the efforts by all economic agents, operating within an organisational and institutional set of arrangements that defines the economic system, to convert the resources available to the economy – labour, capital and natural resources – into the output (goods and services) required by society. The relationship between input and output represents the productivity ratio, that is, output per unit of input. In a world of scarce resources, economic growth and the welfare of society are associated with a long-term improvement in productivity. Improvements in productivity raise standards of living by, *inter alia,* allowing economies to compete effectively in the international division of labour and the exploitation of comparative cost advantages though trade.

Nordas (2006) identifies four possible channels through which trade and foreign direct investment affect productivity levels and growth rates: i) better resource allocation, ii) deepening specialisation, iii) higher return to investment in capital and Research and Development (R&D) and iv) technology spillovers. She outlines the empirical linkages between trade and productivity, and how this occurs through investment, with the indirect link of investment affecting productivity and trade affecting the rate of investment. Trade can therefore raise the return on investment through a more efficient allocation of resources (including capital), economies of scale, competition and lower cost of investment goods where these capital goods embody technology. A problem for trade modellers is that these relationships are difficult to capture as they are not well understood, and Nordas

provides a good survey of the literature as to how modellers have attempted to capture these so-called 'dynamic gains' from trade. They are usually introduced as exogenously imposed conditions rather than being an integrated part of the model, and indeed that is what we do in this paper.

India is demonstrably a genuine BRIC, and Ram Upendra Das (2011) examines the factors behind its recent growth spurt. That paper outlines how India has witnessed wide-ranging economic reforms in its policies governing international trade and Foreign Direct Investment (FDI) flows, and how consequently both trade and FDI flows have risen dramatically since 1991. It finds that significant productivity improvements have taken place in the period since 2000 at the firm level, and it then goes on to examine the important determinants of these productivity improvements. The findings are that important determinants of total factor productivity (TFP) include imports of raw materials and capital goods, size of operation, quality of employment captured by wage rates, and technology imports measured by royalty payments.

Aghion et al. (2008) examine the levels of and linkages between competition and productivity growths in South African manufacturing firms, and compare these against global standards. Their first finding is that mark-ups are significantly higher in South Africa than in corresponding industries worldwide, and furthermore that this is consistent across sectors and did not decline over the period observed. Secondly, and crucially for this paper, they find that these mark-ups are associated with lower productivity rates and that reduced margins would effect greater productivity. Importantly, they examine the causality from competition to productivity growth and confirm that that indeed the benefits start with competition and flow to productivity growth and not the other way around.

Thirtle (2011) discusses the linkages (and time lags) between TFP and research expenditure in agriculture, particularly in the South African context, with output yields in recent years combining with enhanced labour productivity driving agricultural productivity as a result of both public and private sector investment in technology. He laments that in South African agriculture 'TFP growth seems to have stalled', a view consistent with the low TFP rates used in our model for the economy as a whole. We note that the classic East Asian 'growth

miracle' of the last fifty or so years has been largely driven by transferring agricultural labour from the countryside to the towns where this 'surplus' labour has been employed in manufacturing, with firstly Japan and subsequently Taiwan, Korea and Malaysia, and now China exemplifying this growth path. South Africa has followed the first part of the growth pathway (that of labour reductions in agriculture) but unfortunately in recent years it has been unable to successfully negotiate the second and crucial step of developing the manufacturing capacity. Consequently, unemployment is at worryingly high level and ways must be found to reduce these levels. Continuing with the agricultural examination, Liebenburg and Pardy (2010) examined the production and productivity in South Africa over the last half century and found the tendency for land and labour productivity to be slowing down in recent years, and furthermore that multi-factor productivity growth in South African agriculture also slowed.

In the final analysis we are faced with somewhat of a 'chicken and egg' situation as to what exactly are the driving forces operating in TFP: is increased investment driving TFP and trade flows, or are trade flows and increased investment driving TFP? Several points are pertinent here, but the key is that improvements in TFP raise standards of living through allowing this new comparative advantage to be exploited in world trade. This paper does not address how these steps may be taken, but rather explores what the overall impacts are for South Africa when its raises its productivity over time when other economies maintain theirs. In taking this somewhat simplistic approach we eschew getting involved in the voluminous debate over what actually drives this productivity but rather just state that should South Africa become more efficient these are the expected macroeconomic outcomes. Indeed, TFP in the form of firm performance is possibly the key linkage between microeconomics at the firm level and macroeconomics at the country level.

The GTAP database/model

GTAP is supported by a fully documented, publicly available, global database, as well as underlying software for data manipulation and for implementing the model. The framework is a system of multisector economy-wide input/output tables linked at the sector level through trade flows between commodities used both for final consumption and

intermediate use in production. The latest GTAP pre-release **Version 8.3 database** divides the global economy into 119 countries/regions with 57 commodities specified in the database. The database represents global trade in the year 2007 measured in millions of (2007) US dollars.[1]

The standard GTAP model is a comparative, static, general equilibrium model, which means that while it examines all aspects of an economy via its general equilibrium feature (as distinct from a partial equilibrium approach that examines only the sector under consideration), it is static in the sense that it does not specifically incorporate dynamics such as improved technology and economies of scale over time unless these are specifically built in. The economic agents of consumers, producers and government are modelled according to neoclassical economic theory, with both producers and consumers maximising their profits and welfare respectively with markets assumed to be perfectly competitive and all regions and activities linked. Results are measured as a change in welfare arising principally from the reallocation of resources within an economy and the resulting changes in allocative efficiency, terms of trade effects, capital accumulation and changes in unskilled labour force employment and, in this analysis increased TFP. This change in welfare is based upon a representative household, so unless this is modified it is not possible to examine the distributional aspects other than through the skilled/unskilled labour market closures. The standard GTAP model also does not address the time path of benefits and capital flows over time. These changes are important as they allow consumers to borrow, which in turn allows consumption patterns to vary over time.

The interpretation of GTAP results

The GTAP model expresses the welfare implications of a modelled change in a country's growth rate as the Equivalent Variation (EV) in income. The EV in income is simply defined as the difference between the initial pre-FTA income and the post-FTA income after implementation of the change, with all prices set as fixed at current (pre-FTA) levels.

[1] The documentation of the Version 7 database can be found on the website https://www.gtap.agecon.purdue.edu/databases/v7/v7_doco.asp. Documentation of the Version 8 database is not available at this point in time (October 2011).

EV in income = post-FTA income – pre-FTA income

If a country's EV in income increases, the country in question can increase its consumption of goods equal to the increase in income and thereby improve national welfare. The EV is an effective measure for measuring global economic impacts of differentiated economic growth rates between groups of countries, as the EV facilitates a comparison of different growth rate scenarios, given that income changes are measured in initial base prices. These total welfare gains/losses can be decomposed into contributions from improvements in allocative efficiency, capital accumulation, changes in the employment rate of the labour force, terms of trade, contributions from increased productivity and changing populations.

Gains from **allocative efficiency** arise from improved reallocation of productive resources (such as labour, capital and land) from less to more productive uses. For instance, when import tariffs are abolished, resources shift from previously protected industries towards other sectors, which are more in line with the country's comparative advantage, producing an increase in real GDP and economic welfare.

Terms of trade effects are the consequence of changing export and import prices facing a country. So, when a country experiences an increase in its export price relative to its import price (e.g. due to improved market access), it may finance a larger quantity of imports with the same quantity of exports, thus expanding the supply of products available to the country's consumers. Whereas allocative efficiency contributes to increases in global welfare gains, changes in terms of trade affect the distribution of global welfare gains across countries; essentially, one country's terms of trade gain is another country's terms of trade loss. The global total must therefore add to zero, and if a large proportion of the benefits to South Africa from a Free Trade Agreement (FTA) for example are derived from terms of trade effects, this implies transfers to South Africa from the rest of the world.

Capital accumulation summarises the long-term welfare consequences of changes in the stock of capital due to changes in net investment. A policy shock affects the global supply of savings for investment as well as the regional distribution of investments. If a trade agreement has a positive effect on income through improvements in efficiency and/or terms of trade, a part of that extra income will be saved by households, making possible an

expansion in the capital stock. At the same time, rising income will increase demand for produced goods, pushing up factor returns and thus attracting more investments. Generally, economies with the highest growth will be prepared to pay the largest rate of return to capital, and will obtain most of the new investments. Therefore we will tend to see that the long-term welfare gains from capital accumulation reinforce the short-term welfare gains deriving from allocative efficiency and terms of trade.

The welfare effects of changed **employment** rates are consequences of changes in the extent of the unskilled labour force employed due to changes in the real wage. In a situation where the demand for labour and thereby the real wage increases, the amount of labour employed increases, reducing the relative rise in the real wage and thereby increasing the competitiveness of the country's industries (increasing EV in income).

The welfare effect of increased **TFP** arise due to the expansion of the production frontier as more output can be produced with the same bundle of inputs increasing the amount of goods available for consumption, increasing national welfare.

The GTAP simulation

The analysis undertaken in this paper is based upon a variant of the GTAP model to simulate the impact of changes to TFP in South Africa. The database is the Version 8.3 pre-release GTAP database (Badri & Walmsley 2008) with the base year 2007

As with any applied economic model, this model is, of course, based on assumptions, both in terms of theoretical structure and the specific parameters and data used. Regional production is generated by a constant return to scale technology in a perfectly competitive environment, and the private demand system is represented by a non-homothetic demand system (Constant Difference Elasticity function).[2] The foreign trade structure is characterised by the Armington assumption implying imperfect substitutability between domestic and foreign goods.

[2] Hence, the present analysis abstracts from features such as imperfect competition and increasing return to scale, which may be important in certain sectors. We are therefore using what can be thought of as a base GTAP structure.

The macroeconomic closure is a neoclassical closure where investments are endogenous and adjust to accommodate any changes in savings. This approach is adopted at the global level, and investments are then allocated across regions so that all expected regional rates of return change by the same percentage. Although global investments and savings must be equal, this does not apply at the regional level, where the trade balance is endogenously determined as the difference between regional savings and regional investments. This is valid as the regional savings enter the regional utility function. The quantity of endowments (land, labour and natural resources) in each region is fixed exogenously within the model. The capital closure adopted in the model is based on the theory according to which changes in investment levels in each country/region appears online instantly, updating the capital stocks endogenously in the model simulation.[3] Finally, the numeraire used in the model is a price index of the global primary factor index.

The GTAP database has been aggregated down from 119 countries/regions and the 57 commodities specified, focusing the simulation results on manufacturing. For the country/regional aggregation we have used the countries and aggregations as shown in Table 1.

[3] This capital closure adopted in the model is the so-called Baldwin closure as documented in GTAP Technical Paper no. 7.

Table 1: GTAP countries/regions used and their associated GTAP codes

The COMESA, EAC and SADC[4] countries	
ZAF	South Africa
BWA	Botswana
XSC	Rest of SACU (Lesotho, Namibia and Swaziland)
XAC	Rest of Southern Africa (Angola and DRC)
EGY	Egypt,
XNF	Rest of North Africa (Algeria and Libya)
ETH	Ethiopia
MDG	Madagascar
MWI	Malawi
MUS	Mauritius
MOZ	Mozambique
TZA	Tanzania
UGA	Uganda
ZMB	Zambia
ZWE	Zimbabwe
XEC	Rest of Eastern Africa (including Kenya and Sudan)
Other Africa	
MAR	Morocco
TUN	Tunisia
NGA	Nigeria
SEN	Senegal
XWF	Rest of Western Africa
XCF	Rest of Central Africa
Outside Africa	
CHN	China
EU	EU27
US	United States of America
IND	India
BRA	Brazil
LAM	Rest of Latin America
RUS	Russian Federation
RoW	Rest of the world

Source: GTAP database

Note: the countries/regions include:

- The three available groupings for the Southern African Customs Union (SACU) of South Africa and Botswana as countries in their own right and the aggregation for the rest of

[4] COMESA (Common Market for Eastern and Southern Africa), EAC (East African Community) and SADC (Southern African Development Community).

SACU (Lesotho, Namibia and Swaziland). This aggregation is not ideal as the three economies are very different, but there was no alternative at this point in time.

- Another 13 tripartite countries/regions, although note that XNF, the rest of North Africa, includes Algeria with Libya.
- Another 6 African countries/groupings outside the tripartite.
- The remaining groupings of China, the EU, US, China, India, Brazil, rest of Latin America, the Russian Federation and the rest of the world (RoW).

For the GTAP sectors we have used the full set of 16 manufacturing sectors that are available but we often only report on the main sectors of interest. Agriculture is merged into (a) primary agriculture and (b) secondary agriculture, while natural resources and services are merged into their respective aggregated sectors.

Business as usual baseline projection 2007–2020 using World Bank GDP projections

The aggregated GTAP database and model is first used to run a 'business as usual' baseline scenario projecting the world economy from the year 2007 to 2020. This is done by applying exogenous shocks to population, labour and natural resources while the model determines endogenously the level of net investments (increasing capital stocks) and the required level of TFP growth in each country, needed to reach the projected levels of GDP.

The projection of the world economy uses the exogenous assumptions listed in Table 2. The general sources for the assumptions in Table 2 are given in a footnote to the table, and these assumptions represent the best estimates of the possible future path of the data. There are some important departures that we do, however, employ compared to earlier published papers from tralac. Firstly, instead of shocking capital with the same growth rate as GDP we have made capital accumulation endogenous in the modelled base line using the Baldwin closure. This gives larger growth rates for capital than for GDP; therefore TFP growth rates are lower due to the high share of capital. We have made capital accumulation endogenous because we want the model to be able to change the amount of capital in each country/region as we change the assumptions about South Africa TFP growth

rates in alternative baselines. In this initial baseline South Africa has a 0.2 percent yearly growth rate in TFP and the amount of skilled unskilled labour employed grows proportionately with the predicated growth rate in labour force. This means that the initial unemployment rate is unchanged.

Finally, we have also shocked (increased) the amount of natural resources (coal, oil, gas, minerals, fish, forestry) being extracted by 1.5 percent per year in all countries/regions of the world. This is roughly half the growth rate in global GDP as we assume that the world is becoming relatively more efficient in using natural resources. This, in turn, means that the difference between the global output, an increase of 3 percent and the global output of natural resources, an increase of 1.5 percent, has to be explained by global efficiency gains. If we had not exogenously increased the quantity of natural resources being extracted and still endogenously sought changes to GDP from the model, then the model would have to endogenously determine the TFP growth rate needed to attain this growth rate without extracting more natural resources. This, in turn, would require a larger TFP growth rate than the South African 0.2 percent which took account of the 1.5 percent increase in natural resources which was available to increase production within the economy (assuming no changes to the quantity of capital and labour employed in the economy).

The GTAP model then determines changes in output through both an expansionary and a substitution effect in each country/region of the model. The expansionary effect represents the effects of growth in domestic and foreign demand shaped by income and population growth and the assumed income elasticities. The substitution effect reflects the changes in competitiveness in each country/region shaped by changes in relative total factor productivity, cost of production as well as any policy changes. The GTAP model uses this set of macroeconomic projections to generate the 'best estimate' of global production and trade data for 2020. The relative growth rates of each country/region for GDP, population, labour, capital, natural resources and total factor productivity play an important role in determining the relative growth in output of the commodities when projecting the world economy from 2007 to 2020.

The **business as usual** baseline projections with South Africa's TFP at 0.2 are shown in Table 2 for South Africa, Botswana, rest of SACU and the non-African countries/regions used. A complete listing is given in the annex that includes the other African countries/regions. Henceforth we will only report the details for those countries/regions shown in Table 2, but comment on general patterns for the rest of Africa where necessary.

Table 2: Macroeconomic projections expressed as average annual growth rates, 2007–2020

Baseline 1. South African TFP 0.2% per year

	Real GDP	Population	Labour force	Unskilled	Skilled	Capital	Natural resources	TFP
1 ZAF	**3.8**	**0.4**	**1.3**	**1.7**	**1.2**	**5.2**	**1.5**	**0.2**
2 BWA	3.4	0.5	0.8	4.2	0.7	3.8	1.5	0.3
3 XSC	3.6	1.0	0.9	1.8	0.8	5.1	1.5	0.3
23 CHN	8.6	0.6	0.8	3.9	0.8	7.9	1.5	1.0
24 EU	0.9	-0.1	0.0	-0.1	0.1	1.7	1.5	0.1
25 US	1.9	0.7	1.2	0.8	1.6	2.7	1.5	0.2
26 IND	6.7	1.1	1.7	3.9	1.5	7.0	1.5	1.2
27 BRA	3.2	1.0	1.1	3.0	0.9	4.4	1.5	0.2
28 LAM	2.8	1.3	2.3	4.2	1.9	2.9	1.5	0.1
29 RUS	3.5	-0.6	0.0	0.4	-0.1	3.5	1.5	0.6
30 RoW	1.6	1.1	1.7	2.2	1.6	1.8	1.5	-0.1

Source: World Bank forecasts, Walmsley (2006) and own assumptions

Note: The annual growth rate in TFP and capital is determined endogenously by the exogenous variables (GDP, unskilled/skilled labour force and natural resources), the model and the associated database.

South Africa's estimated growth over the period is not impressive: 3.8 percent (or just out of the bottom one-third of the table). While this pales beside the expected continued growth of both China (8.6%) and India (6.7%), it is marginally better than both Russia (3.5%) and Brazil (3.2%) and significantly better than the USA, the EU and the rest of the world. Furthermore, examining the projections for African countries (the annex) reinforces the general perception that perhaps the next decade does indeed belong to Africa, as many economies on the continent are forecast to have growth rates in the four to five percent

range. In general, African population growth rates are forecast to be high, and this modifies the growth projections if the average per capita incomes are to increase over time. Note, however, that South Africa's population growth is not only the lowest in Africa but it is also one of the lowest in the world, so the previous observation is not directly applicable to South Africa.

Step two – TFP now at 0.6 percent annually

In the next step we increase South Africa's TFP growth rate from 0.2 to 0.6 percent. However, there are changes to the modelling procedure. In the first baseline TFP was endogenous and GDP exogenous, thus making it possible to shock GDP using GDP predications according to the World Bank/International Monetary Fund. In this second baseline we make GDP endogenous and shock TFP exogenously using the same TFP growth rates from the first baseline for all other countries/regions with the exception of South Africa which is increased to 0.6 percent. In order to capture the effect of this increased TFP in the South African economy on employment we run another scenario using the post-business-as-usual baseline database from the first simulation where we shock South Africa's TFP from 0.2 to 0.6 using a model where the total amount of employment is determined by the unemployment elasticity (u) using the same method as we have used in tralac's earlier FTA work.[5] We then rerun the second baseline from 2007 to 2020 shocking TFP exogenously (SA 0.6% TFP growth) and shocking the change in the amount of labour force being employed, factoring in the predicted changes from the counterfactual simulation where we increased SA TFP from 0.2 to 0.6 percent. In this second baseline we then capture changes in employment, capital stock (increased investment in the economy through the Baldwin closure with endogenous capital growth) and GDP due to the increase in TFP relative to our first business-as-usual baseline. Instead of making exogenous assumptions about capital accumulation, the model is doing it endogenously. We believe this is the best approach given the exogenous shocks to TFP we are making.

Keeping everything else constant and increasing the TFP in South Africa to an average annual increase of 0.6 percent over the period generates the results as shown in Table 3,

[5]We have used a homogenous unemployment rate for both skilled and unskilled labour.

where the data shows the increases expressed as percentage points over and above our initial baseline at 0.2 percent in the macroeconomic outputs from the model. It is notable that the South African GDP increases by an additional 4.0 percent (i.e. to 7.8 percent) over and above the baseline. Those countries closely associated with South Africa (Botswana, rest of SACU, Malawi, Zambia and Zimbabwe) also gain marginally through their associated with the South Africa, while Brazil declines marginally, suggesting that South Africa and Brazil are competitors on the international scene. One factor driving this GDP increase is the changes to global capital flow, where South Africa and its neighbours benefit at the marginal expense of others. The other feature of Table 3 is the increase in employment in South Africa.

Table 3: Baseline 2 South Africa's TFP increased to 0.6% yearly

Country	Real GDP	Unskilled	Skilled	Capital
ZAF	**4.00**	**0.60**	**0.60**	**5.00**
BWA	**0.10**			**0.20**
XSC	**0.20**	**0.10**	**0.10**	**0.30**
EU				**-0.10**
IND				**-0.10**
BRA	**-0.10**			
LAM				**-0.10**
RUS				**-0.10**

Source: GTAP output, where only those variables registering at the two-digit level decimal point level are shown.

In the initial baseline the yearly growth rate of GDP is 3.8 percent which is matched by an increase in income of 3.4 percent with prices declining by 0.4 per cent. This means that the real income increases by 3.9 percent when prices are fixed (See Table 4). Raising the TFP growth rate to 0.6 increases GDP to 7.8 percent annually in the period from 2007 to 2020.

To put this into perspective, using the average percentage change in income with fixed prices, Table 5 shows how the national welfare in South Africa increases over the years assuming different TFP growth rates. Of course, the approach used in Table 5 presents a very simplistic homogenous growth in incomes given the average percentage growth rates

used. This is because we have used a static GTAP model in this analysis which does not allow us to depict a dynamic time path but only to calculate an average growth rate over the period.

Table 4: Annual percentage changes in income, prices and fixed price income, South Africa

	Percent change in		Percent change in income with prices fixed
	Income	Price	
Baseline 1 with 0.2 TFP	3.4	-0.4	3.9
Baseline 2 with 0.6 TFP	7.3	-0.5	7.9

Table 5: Annual change in income when prices are fixed, South Africa US$ (million)

Year		Total income			Change in income per year		Difference
		TFP 0.2	TFP 0.6		TFP 0.2	TFP 0.6	TFP 0.6 – 0.2
2007		248,050	248,050				
2008		257,644	267,551		9,594	19,501	9,907
2009		267,608	288,584		9,965	21,034	11,069
2010		277,958	311,272		10,350	22,687	12,337
2011		288,709	335,742		10,750	24,471	13,720
2012		299,875	362,137		11,166	26,395	15,229
2013		311,473	390,607		11,598	28,470	16,872
2014		323,520	421,315		12,047	30,708	18,661
2015		336,032	454,437		12,513	33,122	20,609
2016		349,029	490,163		12,996	35,726	22,729
2017		362,528	528,697		13,499	38,535	25,035
2018		376,549	570,261		14,021	41,564	27,543
2019		391,112	615,093		14,564	44,832	30,268
2020		406,239	663,449		15,127	48,356	33,229
Total increase in income from 2007 to 2020					158,189	415,399	257,210

The increase in income shown in Table 5 is also called the Equivalent Variation in income as described above. From the GTAP output we are able to decompose the aggregate welfare results expressed as EV in income into several different components, and we show these

results in more detail in Table 6 below. The data is expressed in increases in dollars (million) resulting from the simulation whereby South Africa's TFP is increased from its expected value of 0.2 to a greater value of 0.6, but importantly these values are now cumulative and not annual changes. Therefore South Africa's aggregate welfare would be around $250 billion higher over the period to 2020 from a 2007 base should the TFP be increased. Data in the table highlights that the main contribution to this increase is from increased capital flows ($127 billion), the TFP changes directly ($64 billion), allocative efficiency gains ($50 billion) and from labour market gains as more people enter the workforce ($15 billion). There are minor losses to terms of trade and investment savings, where these two terms are the components of the terms of trade discussed above, which are aggregated together under 'other effects' in Table 6 where small welfare gains due to increased population are also figured in.

Note also that

- there are small gains to fellow SACU members of both Botswana and the rest of SACU and to the world as a total;
- all other countries/regions lose as a result of South Africa's gains, with the EU and rest of the world being the main losers, and most of these losses are from the increased competition as South Africa becomes a more attractive investment destination.

Table 6: Decomposition of welfare from TFP shock to South Africa expressed as US$ (million) in cumulative values at 2020

Decomposition		Labour	Capital	TFP	Other	
WELFARE	Allocative			Change	effects	Total
South Africa	50,359	15,249	127,271	64,403	-71	257,210
Botswana	26	48	204	18	171	467
Rest SACU	-27	41	371	24	198	607
China	-235	-682	-11,692	-2,468	1,420	-13,657
EU	-7,249	-737	-21,642	-393	1,906	-28,115
US	-3,358	-935	-11,003	-326	-1,236	-16,858
India	-156	-62	-1,356	-287	381	-1,480
Brazil	-1,102	-231	-2,571	-84	-192	-4,180
LAM	-3,294	-496	-4,572	-79	-539	-8,980
Russia	1,869	-137	-6,002	-389	89	-4,570
RoW	-5,074	-1,612	-20,547	323	185	-26,725
Total	31,592	10,493	47,667	60,598	3,209	153,559

Increasing South African TFP to 1.0 percent annually

Table 7 now extends the final step and looks at what would be the outcome for South Africa should it extend its TFP annual increases to 1.0 percent. The data is presented as increases over and above the baseline figures shown in Table 2. The results are dramatic, and we must note, perhaps unrealistically, that although we include this simulation to highlight just how China, and to a lesser extent India, use TFP of around 1.0 percent to fuel their growth, it can be done. The increase in South African GDP is now 7.60 percent over and above the original 3.8 percent from the baseline of a modest 0.2 percent annual increase in TFP. This now places South Africa second in the GDP stakes to the Angola/DRC aggregation, an aggregation literally fuelled by minerals and oils. It is ahead of those BRIC benchmarks of China and India, and significantly ahead of the non-African others. Capital is now increasing at an annual rate of 14.6 percent (baseline 5.2% plus an increase of 9.4%), and, importantly, the labour force is becoming actively engaged in the economy.

Table 7: Baseline 3 South Africa's TFP 1.0% yearly

	Real GDP	Unskilled	Skilled	Capital
ZAF	**7.60**	**1.00**	**1.00**	**9.40**
BWA	**0.20**	**0.10**		**0.40**
XSC	**0.30**	**0.10**	**0.10**	**0.60**
CHN	**-0.10**			**0.00**
EU				**-0.10**
US				**-0.10**
IND				**-0.10**
BRA	**-0.10**			**-0.10**
LAM				**-0.20**
RUS				**-0.10**
RoW				**-0.10**

Source: GTAP output (where only those increases showing at the two-digit decimal point level are displayed)

Clearly TFP is the key to growth. But recall that (a) this is an assumed increase in TFP and (b) modelled keeping all other economies constant in their TFP increases over the period. But we are saying that should South Africa achieve this nirvana, it will not only propel the economy into a real world player but it will also 'coat-tail' those neighbours dependent upon South Africa for their economic activity.

The impacts on trade

Table 8 shows the changes to total exports, with the second column showing the percentage changes for each country from the base with the values expressed as percentage changes in real terms from 2007 levels. Note that South Africa's increase of 38.8 percent is, as expected, far below the large increases from both China and India. Its increase is similar to but below Russia's increase but significantly above Brazil's. It also is similar to that of most African countries, although it lags behind some of the stellar African performers such as Nigeria, but it is far ahead of the sluggish performances from the EU and the US.

Increasing TFP to 0.6 percent yields the increase in exports shown in Column 3, where the exports are another 35.5 percentage points above the base (i.e. a 74.3 percent increase

from the base). Recall that the only change in the model for this simulation is that of the increase to TFP in South Africa, so all other changes in exports are driven by the increases to South Africa's GDP. As expected, neighbours benefit the most. Results for non-African countries are mixed: increases in exports from US, India and Brazil, but declines from China, the rest of Latin America, Russia and the rest of the world as South Africa becomes more competitive globally (although countering this effect is the impact on global exports of increased import demand from South Africa itself). The final column shows the dramatic increase in exports from South Africa following a sustained 1.0 TFP increase over the period. Here exports increase by a further 70 percentage points to more than double from the baseline value. Again, this results in more exports from neighbours in Africa at the expense of those farther away in Africa (with the exception of the rest of West Africa), while for non-African countries the same results are duplicated as before for the 0.6 percent TFP increase, but magnified.

Table 8: Changes in total Quantity of exports
(% for base and % points from base with TFP changes)

	Base		% points change with TFP	
Country /RSA TFP	**0.2 TFP**		**RSA 0.6**	**RSA 1.0**
ZAF	**38.8**		**35.5**	**70.0**
BWA	41.6		2.3	4.4
CHN	181.4		-0.3	-0.7
EU	5.1		0.0	-0.1
US	12.3		0.3	0.8
IND	138.7		0.4	0.9
BRA	14.4		0.3	0.7
LAM	35.0		-0.1	-0.3
RUS	47.9		-0.3	-0.6
ROW	23.8		-0.1	-0.2

Source: GTAP output

The individual GTAP sector export increases are shown in Table 9, with these expressed in terms of **values**. These represent the dollar (million) values of the increases as South African TFP is enhanced from the baseline 0.2 percent annual increases to

0.6 percent. Overall exports from South Africa increase by $21.2 billion, with the rest of the world, the EU, the USA and India as the main destinations. By comparison, increased exports to China and the rest of Latin America and Brazil are rather modest, while exports to Russia actually decline.

By GTAP sector, the big overall increase is in non-ferrous metals where exports increase by $15.5 billion. Looking at actual South African exports in 2010 we find that the main exports in this GTAP sector are semi-processed platinum and gold, with minor contributions from aluminium and copper. Other sectors to benefit are the 'ome' or manufactures of a mixture of heavy machinery that looks like mining equipment in the case of South Africa, vehicles ($3.9 billion), and chemicals, rubber and plastics ($1.9 billion). By destination the big increases are to the rest of the world, Europe, the USA and India. Exports of both primary agriculture and natural resources both decline heavily as the emphasis moves to South African manufacturing. Within the BRIC countries exports to Russia actually decline while those to Brazil increase marginally ($132 million). Not shown is that, within Africa, exports to both SADC and the rest of Africa increase by around $1.8 billion, with the same sector patterns showing, while exports to fellow SACU members increase by $ 759 million.

Table 9: Changes to South African Value of exports, TFP 0.2 to 0.6, US$ (million) at 2020

Exports to	Total	RoW	EU	USA	IND	CHN	LAM	BRA	RUS
GTAP sector									
total	21,186	7,005	4,727	4,193	2,033	403	186	132	-9
nfm	15,488	5,816	3,192	3,019	2,055	1,065	54	43	5
ome	2,166	268	919	138	6	24	29	11	11
mvh	1,936	735	538	264	2	7	14	19	2
crp	1,822	298	371	254	93	94	45	49	14
i_s	1,425	452	386	128	25	201	45	23	1
omf	1,041	71	214	430	3	239	7	1	4
S_agr	538	117	111	28	5	10	4	1	3
ele	234	18	61	4	2	1	2	1	0
ppp	205	47	56	5	8	7	2	1	0
p_c	157	15	28	12	3	6	1	1	1
fmp	100	8	24	2	0	1	4	0	0
otn	83	18	28	5	0	0	4	0	1
lea	75	12	28	13	0	6	3	0	1
tex	47	6	9	2	1	2	0	1	0
nmm	34	2	10	1	0	0	1	0	0
serv	23	3	7	2	0	1	0	0	0
lum	19	4	4	0	0	0	0	0	0
wap	-8	-3	-4	0	0	0	0	0	0
P_agr	-1,815	-449	-505	-64	-80	-268	-19	-2	-46
Nat	-2,387	-432	-752	-50	-91	-993	-10	-18	-5

Source: GTAP output. Where S agr is secondary agriculture; P agr is primary agriculture; nat is natural resources; serv is services; and the manufacturing sector codes are as given in Annex Table 3.

Following on from Table 9, Table 10 represents the same data expressed as percentage changes in **values** from TFP at 0.2 to TFP at 0.6 by GTAP sector as South Africa becomes more technically efficient in its manufacturing sectors. Note that the average increase in the **quantity of exports** as shown in Table 8 is 35.5 percent, while the total change in **value of exports** is a lesser 20 percent as shown in Table 10. Given the aggregated nature of these GTAP sectors we are unable to assess the extent to which this is an aggregation issue and the portfolio of goods within the sectors is changing towards higher valued items or there is a lowering of export prices as South Africa becomes more efficient (or both).

In general, these percentage changes are similar those shown for the dollar value increases, and as a function of the model assumptions the percentage increases are relatively consistent for most markets across the individual GTAP sectors. There are, however, some important differences. By percentage, the largest increases are now to India and the US, both with a 38 percent increase in total. The rest of the world records an increase of 28 percent, while the second largest increase by value as shown in Table 6, the EU, is marginally behind Brazil's 19 percent. Thus, with only India and Brazil in the top five by percentage increase and India and China by dollar value increases, the BRICs by no means stand out as being the star performers as assessed by either increased dollar values (Table 6) or percentage changes (Table 7). The slower growing economies of the EU, the USA and the rest of the world remain crucial to South Africa's export performance. Several sectors increase by less than 10 percent overall, and these are not shown here in Table 7 (secondary agriculture, petroleum products, fabricated metals, other mineral products, textiles, lumber and services), while natural resources and primary agriculture decline significantly to all markets as shown. Note on the right-hand side of Table 7 that exports to Russia actually decline and exports to China increase only marginally. Note also the ordering of the sectors by percentage changes is different from their rankings by values terms. While non-ferrous metals remain number one in both tables, other manufactured products and electrical goods become relatively more important when assessed by percentage changes.

Table 10: Percentage changes to South African value of exports, TFP 0.2 to 0.6 at 2020

Sector/Country	TOTAL	IND	USA	ROW	BRA	EU	LAM	CHN	RUS
total	**20%**	**38%**	**38%**	**28%**	**19%**	**18%**	**15%**	**4%**	**-2%**
nfm	61%	56%	60%	62%	64%	65%	67%	66%	65%
omf	49%	51%	51%	50%	50%	51%	50%	47%	51%
ele	28%	34%	34%	34%	34%	34%	34%	35%	34%
crp	26%	31%	35%	34%	35%	35%	34%	34%	37%
ome	26%	31%	31%	31%	31%	31%	31%	32%	31%
mvh	26%	32%	32%	32%	32%	31%	32%	31%	32%
lea	18%	24%	23%	23%	23%	24%	23%	23%	24%
i_s	17%	18%	18%	19%	18%	19%	18%	19%	18%
ppp	11%	11%	12%	12%	11%	12%	12%	12%	14%
otn	10%	10%	10%	10%	10%	10%	10%	10%	10%
wap	-2%	-7%	-7%	-7%	-7%	-7%	-7%	-7%	-7%
Nat	-17%	-15%	-18%	-17%	-17%	-18%	-17%	-17%	-18%
P_agr	-26%	-31%	-29%	-29%	-31%	-28%	-29%	-31%	-29%

Imports into South Africa

The comparable changes to imports are shown in Table 11 for the aggregate big picture. Here the changes are more pronounced than those for exports, with imports at the base projection up 62.8 percent in real terms from 2007, while the enhanced TFP projections are for an extra 71.4 percentage points or 134 percent (more than double) above the 2007 level. This now places South Africa in the top league of export performers. The unlikely scenario of South Africa raising productivity to India-Chinese levels of 1.0 actually sets South Africa out as the global star export performer as shown by the cumulative changes on the right-hand side of the table.

Table 11: Changes in total Quantity of Imports
(% for base and % points from base with TFP changes)

	Base		% points change with TFP	
Country /RSA TFP	0.2 TFP		RSA 0.6	RSA 1.0
ZAF	**62.8**		**71.4**	**159.5**
BWA	43.7		6.0	10.7
CHN	81.8		-0.3	-0.7
EU	13.7		-0.2	-0.5
US	43.6		-0.3	-0.8
IND	65.1		0.0	0.0
BRA	67.6		-0.5	-1.2
LAM	38.4		-0.5	-1.1
RUS	38.5		-0.5	-1.1
RoW	26.5		-0.3	-0.6

Source: GTAP output

Next we show the details of South African imports by GTAP sector and country/region. Again, Table 12 shows the values of the changes from the base simulation with TFP at 0.2 percent and the outcome for an enhanced TFP change of 0.6 percent annually, with Table 10 showing the same outcomes by percentage changes from the baseline 0.2 TFP scenario. Imports increase for

all sectors, with natural resources, vehicles, electrical goods, other machinery and services dominating. Other than the big increase from China ($10 billion), imports from the BRIC countries are not as large as those from the EU, the rest of the world or the US, and indeed of no more importance than those imports from African sources (not shown). The increases from Brazil are modest ($846 million, with motor vehicles and secondary agriculture the main sectors), while the relatively small increase of $249 million from Russia is dominated by natural resources as South African exports in this sector decline, as shown above. This increased South African imports from neighbouring African countries explains much of the macroeconomic results for these economies as an expanding South African economy imports more from the continent, By sector, vehicles are interesting, as the large increase comes not from the BRICs but from the EU and the rest of the world. In clothing China dominates as expected. In both primary and secondary agriculture the increases are more evenly spread between the EU with 24 percent of the total, the rest of the world 22 percent, Latin America (Argentina) 19 percent, and the US and Brazil with 9 percent each.

Table 12: Changes to South African value of imports, TFP 0.2 to 0.6, $ (million) at 2020

	TOTAL	EU	ROW	CHN	USA	IND	LAM	BRA	RUS
Total	**49,598**	**14,988**	**12,057**	**10,056**	**3,449**	**1,830**	**1,239**	**846**	**249**
ome	10,911	4,011	1,932	3,215	941	460	91	142	1
mvh	7,063	2,868	2,307	727	439	348	76	269	1
serv	5,795	2,248	1,627	297	741	45	229	17	49
ele	5,125	1,285	769	2,683	164	118	71	6	0
Nat	4,007	603	2,133	3	21	6	79	22	174
nfm	3,314	149	461	216	40	35	2	6	12
crp	3,081	1,266	761	421	283	245	34	26	5
S_agr	1,445	414	367	27	57	31	236	194	1
P_agr	1,300	252	226	18	190	5	285	58	0
otn	1,171	389	212	116	270	45	6	25	1
tex	959	138	244	427	19	61	4	3	0
fmp	932	251	142	409	34	73	3	5	1
wap	815	34	80	554	5	55	2	0	0
ppp	692	362	142	53	56	10	38	5	1
nmm	664	227	144	201	26	25	8	24	0
p_c	602	80	188	53	104	164	2	5	0
i_s	521	174	111	91	8	60	41	14	5
lum	491	121	100	179	16	3	13	9	0
omf	360	74	58	160	31	30	1	1	0
lea	352	41	52	208	3	11	17	15	0

Source: GTAP output

The percentage changes to South African **value of imports** are consistent across importing sources, which is a function of the manner in which the Armington assumption of trade models generates these results. They do, however, vary by GTAP sector, with the largest percentage increase being in electrical machinery (59%), followed by primary agriculture (58%), other transport equipment and services (55%) and non-ferrous metal products (51%). The chemical, rubber and plastics sector shows the lowest percentage change at 26 percent.

Employment

Table 13 shows the effects that increasing TFP in South Africa can be expected to have on employment in the country. The baseline projection with continued TFP at 0.2 percent annually is not sufficient to change these current unemployment rates from their 23 percent level. Increasing TFP to 0.6 percent will, however, reduce unemployment to 17 percent, while the large increase to 1.0 percent will have a spectacular result as unemployment is calculated to reduce to 12 percent. The policy implication is clear: TFP holds the key for employment in South Africa.

Table 13: Impacts on employment in South Africa

South African unemployment rate				
	Base 2007		2020	
Assumed TFP growth rate SA		0.2	0.6	1.0
Unemployment rate %	23	23	17	12

Source: GTAP output

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Annex

Annex Table 1 Baseline : South African TFP 0.2% per year

	Real GDP	Population	Labour force	unskilled	skilled	Capital	Natural resources	TFP
1 ZAF	**3.8**	**0.4**	**1.3**	**1.7**	**1.2**	**5.2**	**1.5**	**0.2**
2 BWA	3.4	0.5	0.8	4.2	0.7	3.8	1.5	0.3
3 XSC	3.6	1.0	0.9	1.8	0.8	5.1	1.5	0.3
4 EGY	4.9	1.4	1.7	2.2	1.7	5.8	1.5	0.6
5 MAR	4.7	1.3	2.1	2.6	2.1	5.3	1.5	0.6
6 TUN	4.0	1.2	2.1	4.5	2.0	4.4	1.5	0.2
7 XNF	3.3	1.4	2.2	3.6	2.0	3.7	1.5	0.1
8 NGA	5.8	1.8	3.0	3.4	2.9	9.6	1.5	0.3
9 SEN	4.0	1.9	2.9	4.2	2.9	4.3	1.5	0.2
10 XWF	3.8	2.0	2.6	3.1	2.5	5.3	1.5	0.1
11 XCF	4.6	2.1	3.3	3.9	3.2	5.6	1.5	0.2
12 XAC	11.7	2.8	1.8	3.3	1.8	16.1	1.5	1.8
13 ETH	8.2	2.0	2.7	3.2	2.7	9.8	1.5	1.6
14 MDG	5.2	2.3	2.9	3.4	2.9	4.6	1.5	0.7
15 MWI	5.6	1.7	2.6	4.1	2.6	6.7	1.5	0.7
16 MUS	3.4	0.9	3.5	5.6	3.4	3.6	1.5	-0.1
17 MOZ	6.7	1.0	2.7	4.1	2.7	8.9	1.5	0.6
18 TZA	6.6	1.6	2.7	-0.8	2.7	6.6	1.5	1.2
19 UGA	6.0	2.7	3.1	5.9	3.1	7.6	1.5	0.9
20 ZMB	5.3	1.1	2.8	4.3	2.8	6.2	1.5	0.4
21 ZWE	0.0	0.7	1.6	3.2	1.6	0.2	1.5	-0.5
22 XEC	5.2	1.7	2.3	3.2	2.3	6.1	1.5	0.6
23 CHN	8.6	0.6	0.8	3.9	0.8	7.9	1.5	1.0
24 EU	0.9	-0.1	0.0	-0.1	0.1	1.7	1.5	0.1
25 USA	1.9	0.7	1.2	0.8	1.6	2.7	1.5	0.2
26 IND	6.7	1.1	1.7	3.9	1.5	7.0	1.5	1.2
27 BRA	3.2	1.0	1.1	3.0	0.9	4.4	1.5	0.2
28 LAM	2.8	1.3	2.3	4.2	1.9	2.9	1.5	0.1
29 RUS	3.5	-0.6	0.0	0.4	-0.1	3.5	1.5	0.6
30 ROW	1.6	1.1	1.7	2.2	1.6	1.8	1.5	-0.1

Source: World Bank forecasts, Walmsley (2006) and own assumptions

Annex Table 2: regional changes in trade

	% real change for baseline at 2020	
	Exports	Imports
South Africa	39	63
Botswana	42	44
Rest of SACU	39	55
Egypt	38	62
Morocco	37	52
Tunisia	52	47
Libya/Algeria	32	43
Nigeria	108	127
Senegal	67	61
Rest of West Africa	36	73
Rest of Central Africa	44	66
Angola/DRC	81	216
Ethiopia	89	144
Madagascar	82	45
Malawi	37	77
Mauritius	46	42
Mozambique	137	133
Tanzania	121	89
Uganda	103	109
Zambia	87	88
Zimbabwe	3	18
Rest of East Africa	35	78
China	181	82
European Union	5	14
United States	12	44
India	139	65
Brazil	14	68
Rest of Latin America	35	38
Russia	48	39
Rest of the world	24	27

Annex Table 3: GTAP Manufacturing Sectors

Code	Description
TEX	Textiles
WAP	Wearing apparel
LEA	Leather products
LUM	Wood products
PPP	Paper products, publishing
P_C	Petroleum, coal products
CRP	Chemical, rubber, plastic products
NMM	Mineral products nec
I_S	Ferrous metals
NFM	Metals nec
FMP	Metal products
MVH	Motor vehicles and parts
OTN	Transport equipment nec
ELE	Electronic equipment
OME	Machinery and equipment nec
OMF	Manufactures nec

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