

A Poverty Focussed CGE Model for South Africa

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May 2000

ABSTRACT: In this paper I present a computerised general equilibrium (CGE) model that focuses on the impacts of liberalisation on poverty in South Africa. I begin by giving some general motivation for using a CGE in the first place. I then give an informal introduction to the CGE model section by section, discussing the relevant data for South Africa in each section as I move through. Finally, I move on to a presentation and discussion of the results. I leave the formal statement of the model to an appendix. The punchlines of the model are: liberalisation –good for the poor, good for the non-poor, bad for inequality. The lessons are that to achieve these effects the South African economy needs to see a large shift in resources towards primary industries. And that the very poor could be at risk of losing income if reductions in government transfers are not compensated by revenue gains from other sources.

1.1 Motivation

We should stress...that one should avoid drawing general conclusions from the two-good results. The moral...is that one cannot say much about the general equilibrium effects of changes in parameter without knowing the exact values of the parameters and the exact characteristics of the demand and supply functions. If the theory is to be applied therefore, it should be done by putting numerical values into the general formulae; not by applying qualitative results from the two-good case directly. (Dixit and Norman, 1980: pp127-128)

We have seen reasons why we may expect trade policy to have adverse impacts on the poor in developing countries. But in looking in detail at particular features of an economy, –at technological difference and at features of the labour market– we have ignored the complex relations that we introduced at the beginning of this thesis. We have moved quite far away from real data and we have lost sight of many of the channels through which poverty may be affected by trade policy. It is now time to return to the big picture.

Why do it with a CGE model? CGE models have their problems. They presume a tremendous faith on the part of the modeller regarding her understanding of how an economy functions; she is after all attempting to model an entire economy. CGE models often are static, ignore expectations, rely heavily on assumptions regarding competitive behaviour, rely on parameters that have little econometric support, reduce politics to policies and, as pieces of quantitative analysis, they are astonishingly poor at providing estimates of uncertainty surrounding their output. None of these problems are inherent to CGE modelling; but they are very common. The model I produce in this paper is subject to every one of these criticisms.

The answer to the “why do it?” question is in large part related to the lack of alternative approaches for understanding important trade related policy issues. At a high level of aggregation, with many goods and factors, economic theory on its own gives us little certainty how liberalisation is likely to affect specific groups. What the detailed distributive affects of liberalisation are, is –to use a well worn phrase– an

empirical question. And many other empirical approaches have failed to prove very satisfactory.

Econometric efforts to answer related questions regarding changes in wages or employment have oftentimes run into severe difficulties. The root of the problem is that almost everything is endogenous. The price of one good will be affected by the tariffs on another; the cost of labour in unprotected sectors will be related to the costs of labour in unprotected sectors and so on. Many papers have failed to take these facts into account¹.

Other approaches mix empirics with simulation in a more partial manner than do CGEs; again failing to capture the full range of interrelations. Yrarrazaval *et al.*'s recent study of Peru (1999), or Levinsohn *et al.*'s recent study of Indonesia (1999) are two such cases that use a similar approach. The approach consists in forecasting changes in prices due to changes in tariff rates. With superscripts denoting time, the authors assume that elements in the price vector may be captured by the expression $p^2 = p^1/(1 + \text{tariff})$. They then take the difference in the cost of a time 1 consumption bundle at time 2 prices and at time 1 prices: $\underline{x}'p^2 - \underline{x}'p^1$ as a measure of welfare losses. The sum will necessarily be negative, implying a welfare gain. These gains are then summed over consumers. A similar exercise is undertaken for producers.

The approach is clearly limited. It involves no concept of relative prices and ignores the effects of tariffs on one good on prices of another. In a similar vein it ignores the existence of non-tradables. It ignores the fact that through re-optimising, consumers may have effects on some producers. Furthermore, by failing to allow for reoptimisation by producers and consumers we gain no insights of what types of industries expand or collapse and how relative wages change as a result. Finally, there is a large set of important factors resulting from a change in trade policy that are

¹ Ann Ravenga's econometric study on trade, wages and employment in Mexico, for example, fails to take account of the severe endogeneity of price and quantity relations that are likely to result from liberalisation. In Ravenga's study she regresses firm level wages and employment on own-good tariff changes. The intuition is that the price of a liberalised good will fall and hence firms will move to cut employment and, in her bargaining model, drop wages. In fact it should be very clear that while the marginal affect of own tariffs may matter, it is essential to understand the effects of tariffs on *other* goods to understand outcomes; not simply because of their effect on demand and the final relative price of the firm's good but also because of their effect on intermediate input prices. Models of this form are common.

entirely ignored by the authors: changes in the factor returns and changes in government revenues, with the consequent effects on transfers, in particular.

Perhaps the least sophisticated quantitative approach to the study of the relations between trade and poverty is taken by cross sectional reduced form studies. These studies ignore the mechanisms that link trade policy to poverty and search for cross-national correlations between policy and poverty. Prominent examples of this approach are Demery and Squire (1996), Stryker and Pandolfi (1997), and Eusufzai (1998).

These studies by their nature tell us little either of the mechanisms whereby trade effects poverty or the manner in which income is redistributed in an economy subsequent to policy reform. What they lose in detail they hope to gain from cross-country comparison, which allows them to control for other factors effecting poverty in a country. But cross country comparisons come at a price, they require the creation of measures of poverty and of trade policy that are comparable across countries, and a good measure is hard to find. And typically isn't.²

Why do a CGE of the South African economy? Other models exist. A review essay on CGEs for the South Africa economy shows that there are at least four other CGE models with a good degree of variation between them. Some, such as Devarajan and van der Mensbrugge are more developed and more detailed than this one and many consider trade reform in some detail. The answer lies in the emphasis of this paper on poverty.

Other models have not paid particular attention to poverty; they have not focussed on the details of the sources of income of the poor and they have not paid attention to the relations between labour markets and the income of the poor; it is in these areas that this model provides its value added.

² Stryker and Pandolfi for example tackle the problem of finding a comparable measure of poverty by using an unweighted average of a large collection of social indicators: life expectancy, literacy etc. Clearly this is a very crude measure, incorporating some indicators that move very slowly over time (literacy) and other that move quickly. Their measures of trade policy are primarily incidence measures with the exception of their employment of the Sachs-Warner dummy. Like other studies of this kind they do little to take account of problems of endogeneity and spurious causation. See Rodrik and Fernandez 1999 for unrelenting criticism of the Sachs-Warner and other measures of trade openness.

We note also the appositeness in timing for a model of liberalisation in South Africa. Despite the fact that South Africa began liberalising its economy as early as the 1970s, the focus was on reducing export bias and South Africa did not begin any import liberalisation and tariff reduction until 1995. It then began a five year extensive tariff reduction program.³

1.2 Model

Overview

The CGE model presented in this section is of a small open economy model with three types of consumer: non-poor, poor and very poor; three factors: capital, skilled and unskilled labour; and nine goods: non-traded, import and exported variety from each of three sectors. The model has a government sector that draws revenue from direct taxes on production, taxes on the income of the agents of the economy and tariffs on imported goods. The model is for the most part Walrasian with the exception that unemployment exists in each of the labour factors. A formal statement of the model is given in Appendix 3.1.

Data

The data is drawn primarily from a simplified version of the 1992 South African Social Accounting Matrix (SAM) with some supplementary labour market and tariff rate data from other sources. The base year SAM is provided in Appendix 3.2 alongside a simulated SAM resulting from the removal of all tariffs. Together these SAMs provide an excellent summary of the economy and how it is altered due to tariff changes. Other data used in the model is described in relevant sections below. Appendix 3.2c provides a guide for interpreting cell entries in the SAM.

³ See Bleaney *et al* 1999 for a history of trade liberalisation in South Africa, in: Oyejide, Ademola, 1999.

Goods Markets

I aggregate goods into just three types: primary goods, including mining and agriculture⁴; industrial goods, including consumer goods, intermediate goods, capital goods, utilities and construction; and services. Optimistically, I assume that the markets for all three goods are perfectly competitive and so I expect to see market clearing.

As may be expected these three goods differ substantially in their input structure in terms of imported and domestic intermediate goods and in terms of their value added components. Figure 1 shows the composition of value added for the three goods. We see, that agriculture and mining are associated with both capital and unskilled labour and use little skilled labour; services rely most heavily on skilled labour and use little unskilled labour; industrial goods lie in between with a fairly even mix of inputs.

Decomposition of Value added by Sector

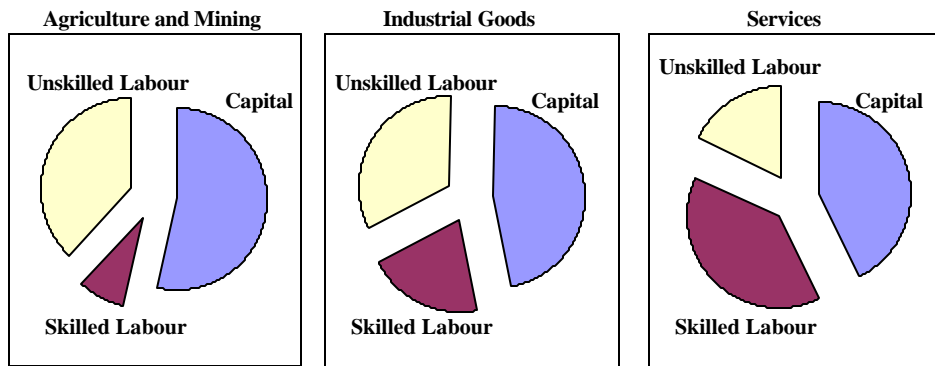


Figure 1

⁴ A larger model capable of handling more sectors would have to distinguish between the agricultural and mining sectors. This model has been somewhat compromised by treating them as a single sector. Although they both employ a lot of unskilled labour they have very different trading statuses: mining exporting a much larger share of its production than agriculture. Furthermore because of the oligopolistic nature of the mining industry (nationally as well as globally) as well as the natural resource constraints on it, it may well be unrealistic to assume that its export behaviour would change in the competitive manner described here.

The three also stand in markedly different positions in terms of their relation to trade. As we will see in Table 2 below, the three types face very different levels of protection. In Table 1 we see that agriculture and mining, though relatively small sectors, account for about half of all exports; a very large share of their produce is exported. Services export little of their produce and account for little as a share of exports.

In terms of imported intermediate goods there are again interesting and important variations. The industrial sector imports the most; the share of inputs in its production is twice that of the other sectors. For all sectors, industrial goods constitute the largest part of their imported inputs.

While the agricultural/mining sector imports industrial goods almost uniquely, industrial goods constitute only a third and a half of imported inputs for industrial production and services respectively. The former rely heavily on agricultural and mining imports while the latter rely more on imported services. Indeed, the services sector is the only one to use trade in imported services. All of this information is contained in the SAM and is presented in summary form in Table 1.

	Primary	Industrial	Services
<i>Share of Sector in Total Production</i>	0.12	0.51	0.37
<i>Share of Sector in Exports</i>	0.50	0.34	0.16
<i>Share of Sector that is Exported</i>	0.58	0.09	0.06
<i>Share of Sector's Expenditure on Inputs given to Imports</i>	0.06	0.11	0.05
<i>Share of Primary goods within imported inputs of Sector</i>	0.06	0.26	0.01
<i>Share of Industrial goods within imported inputs of Sector</i>	0.92	0.65	0.54
<i>Share of Services within imported inputs</i>	0.03	0.09	0.45

Table 1

Trade

As is common for this kind of exercise I make use of the “Armington” assumption. That is, I assume that imports, exports and non-traded varieties of a given good are imperfect substitutes. At the level of aggregation I am working there is little alternative to this assumption since every good is both imported, exported and consumed locally.

On the consumption side this means that consumers choose between imports and domestic varieties of given goods, the degree of substitutability is given by a fixed elasticity of substitution parameter on a CES utility function.

For producers, the Armington assumption means that they produce an “aggregate” good, which they then transform into an export or domestic variety. The ease with which they can switch between domestic and exported goods is given by an elasticity of transformation parameter on a CET production function. Like consumers, producers also choose between imported and domestic varieties of goods when they select their intermediate products. The values for the elasticities are the same for producers and consumers and for substitution and transformation. The values used, taken from Devarajan and van der Mensbrugge 1999 are given in Table 2 below.

Two sets of tariff data were used. One was imputed from the SAM for 1992 and corresponds to collection rates; and the other, in general larger in magnitude, is taken from work done by Merle Holden and used by Devarajan and van der Mensbrugge. It turned out that the choice of rates affects the magnitude of the impact of reform but had no qualitative effects. Since the latter are closer to those rates reported elsewhere than the imputed rates we report only results from runs using these rates. These rates for our three goods are reported in Table 2.

Elasticities and Tariff Levels			
	Primary Goods	Industrial Goods	Services
Holden Rates	7%	14%	0%
CES/CET Elasticities	3	2.5	1.5

Source: Devarajan and van der Mensbrugge 1999.

Table 2

Agents

Besides the firms there are four agents in the economy: the government and three consumers. The three non-governmental agents are selected on the basis of their income and represent the non-poor, the poor and the very poor.

The three groups are of unequal size and have been chosen in order to focus on the poor while maintaining a small number of agents. Table 3 gives information relating to the population, total income and *per capita* income of the three groups.

The non-poor form the largest group, accounting for 55% of the population. On the basis of the 1992 SAM this category contains *all* White, Asian and Coloured households as well as the richest 40% of Black households.

The poor constitute 30% of the population. In terms of 1992 US, dollars the twelve million people in this group live on about \$650 a year.

The very poor group is the smallest subgroup. It nonetheless contains six million people who live on just \$152 per year.

The Size and Wealth of Agents

	Non-poor	Poor	Very Poor
Population (share)	21,440,000 (55%)	11,910,000 (30%)	5,955,000 (15%)
Income (share)	221,929 (90%)	21,990 (9%)	2,582 (9%)
<i>Per Capita</i> Income	10,351	1,846	433

Table 3

The data shows considerable income inequality. The non-poor receive 24 times the *per capita* income of the poor. Nonetheless the aggregation at the top hides much greater inequality. I have also suppressed race information, but as we would expect, income inequality over the period had a very strong racial character. The whites, as a group, have a population of about 5 million people, approximately the size of our very poor category. Their *per capita* income is, however, 60 times that of the very poor. The top decile of whites has 140 times more income *per capita* than the very poor. The poor and non-poor categories are made up entirely of Blacks.

Agents derive their income from factor payments, transfers from government and transfers from the rest of the world. As may be expected they differ in terms of where they get their income. The wealthy rely on income from skilled labour, and, more than any other group, on returns to capital. The poor rely on unskilled labour and the very poor mostly on transfers, particularly from government.

The distribution provides some support for considering changes in factor returns as a short hand for income distribution. Certainly wealthier groups have relatively more skilled labour and capital; poorer groups have relatively more unskilled labour. But one of the messages of Table 4 is that we should not rely too heavily on this short hand. All groups receive income from all sources; the poor rely less on returns

from capital than the very poor. Perhaps the most important lesson is that much of the income of the very poor derives only indirectly from the production side of the economy. It turns out that one of the primary ways in which the poor are touched by liberalisation in the CGE model is through the drop in transfers from government.

Agents' Sources of Income (as a percentage of Agent's Income)

	Non-Poor	Poor	Very Poor
<i>Returns to Capital</i>	23%	9%	12%
<i>Wages from Skilled Labour</i>	40%	9%	3%
<i>Wages from Unskilled Labour</i>	33%	67%	29%
<i>Transfers from Government</i>	4%	10%	29%
<i>Other transfers</i>	1%	5%	27%
	100%	100%	100%

Table 4

I assume a simple nested structure for consumer preferences. Agents set aside a fixed share of income for transfers and saving and spend the rest on consumption. They have CES preferences over import and domestically produced varieties of all goods. The elasticities of substitution for these preferences are taken from Devarajan and van der Mensbrugghe 1999. The share and intercept parameters are calibrated from the data. Consumers have Cobb Douglas preferences over the three aggregate goods, representing primary, secondary and tertiary industries. It turns out from the data that consumer demands of the three agents are very similar, particularly between the poor and very poor. The non-poor consumer more imports on average; they save more and more of their income is spent on transfers. Remarkably perhaps they pay considerably less on taxes; about 21% of their income is spent on taxes as opposed to over 25% for the poor and non-poor. As we have assumed demands to be homothetic, the implication is that we lose little more in restricting the number of agents to be small.

The data we have on imported consumer goods does not distinguish between consumer types. Hence we have imputed baseyear consumption of each good to each consumer type on the basis of total imported consumer goods of each type and the budget share allocated to imports of each type of consumer.

Production

In line with the Armington assumption, I take it that firms have the technology to produce an aggregate good say “services”. They then tailor this aggregate good to prepare it for sale on the domestic market or for export. The ease with which they can substitute between varieties is captured by a constant elasticity of transformation function. It is for example fairly easy to switch between for-export and domestic varieties of agricultural produce, but more difficult to make such switches for services. The aggregate good is produced with a nested production function. Firms choose levels of factors, capital and both types of labour, and of aggregate intermediate inputs using a Cobb-Douglas technology. Once a level of intermediate inputs is chosen firms choose between domestically produced and imported varieties of inputs using a CES function similar to that used by consumers. To simplify I have suppressed the input of imported factors. These were in any case small.

Prices

I use the nominal exchange rate as the numéraire. Hence all prices are given in terms of world prices. Units are chosen such that all pre-tax prices are set to unity. I have also two consumer price indices, one for the poor, broadly defined, and one for the non-poor. In practice the two consumer price indices move together almost perfectly. These indices are weighted averages of the prices of import/domestic aggregates. Using aggregates of import and domestic varieties means that the price index takes account of substitution possibilities and more accurately captures the real cost of living than does a the price of a basket of simple goods. When I report “nominal” values, these refer to dollar equivalent values since I am using the exchange rate as numéraire. When I report “real” wages, and “real” income etc, these are given by the dollar values divided by the (poor’s) consumer price index.

Factor Markets

South Africa is an economy that by all accounts has very high levels of unemployment. With unemployment rates for the period as high as 30% it is simply unreasonable to assume that factor markets clear. We introduce unemployment in the model by assuming that there exists benchmark unemployment of both skilled and unskilled labour. However, the data we have for unemployment is for unemployment of people and not of factors and we do not have data directly on unemployment of skilled and unskilled labour. We use the closest alternative we can find which is data on unemployment of high and low educated workers.

We then assume that factors engage in a search and match process. We do not, however, have data on which sector searchers search in and so cannot reasonably distinguish between levels of unemployment by sector. Instead we assume, in the spirit of previous work that matching within each factor is an increasing function of the wage of that factor⁵. Essentially then we are assuming the existence of a wage curve. As discussed by Kingdon and Knight 1999, while there is a tendency in the literature to see the wage curve as resulting from a mapping from unemployment to wages, it may also be due to a mapping from wages to unemployment. As well as explanations considered in their work we might also think that increased wages improve the quality of the search process. People look harder or are discouraged less easily when the prize is larger; firms may place greater resources into search when demand is more pressing.⁶ A final –more conventional– interpretation may simply be that people’s labour supply decision is a function of wages, and that hence total labour supply will be increasing in wages. Under this justification for the specification of the model we leave to one side the

⁵ See for example Maechler and Roland-Holst and the discussion therein.

⁶ We note, however, that an interpretation more in the spirit of Harris and Todaro (1970) might argue that if households have a margin of choice in their selection of factors to employ, then they will allocate factors to the point where compensated wages equalise across factors. The implication of this argument would be that to search in a high unemployment factor market, workers would need to expect high wages upon finding a work. This implies a positively sloped wage curve. But we note that this compensation argument is only valid when searchers can choose between high unemployment and low unemployment markets. We do not expect that workers or households have much leeway in the choice which factor markets to search in –except in the very long run by investing in children’s education and so on.

normatively charged issue of whether unemployed labour is voluntary or involuntary⁷. To allow for this labour supply choice interpretation and because disincentive effects in the South African labour market are reportedly large we use a measure of “broad unemployment” reported in Table 3 of Kingdon and Knight (1999) and drawn from household survey data.

The actual functional form we use is given by $u(w) = (1 + \exp(\alpha + \beta w))^{-1}$ with $\beta \geq 0$. Besides the nice properties of the logistic form, the function is also a special case of one used by Maechler and Holst (1997), drawing for micro foundations of work by Hosios (1990). I have calibrated the parameters α and β to match econometrically derived measures of South Africa’s wage curve elasticities, estimated in the locality of benchmark unemployment. These wage curve measures have been developed from cross sectional data. The model treats of liberalisation as impacting upon wages, which then produces a shift along the wage curve. It is possible that liberalisation may induce a shift in the wage curve itself. If increased openness reduces the bargaining power of workers, we may expect a downward shift in the wage curve. In fact it should be noted that there may have been an *upward* shift in the curve over the 1990s⁸. But since we have no strong *a priori* reason to expect *liberalisation* to shift the curve itself in any direction, we focus on movements along the curve. As a robustness measure I do a number of experiments with an upward sloping wage curve. As we shall see below, the change of assumption is of some consequence; especially for the very poor. Note finally, that in line with these interpretations we use a measure of real wages rather than nominal wages⁹.

The benchmark unemployment and wage curve elasticity rates used are given in Table 5.

⁷ Straying back into more normatively charged areas we note that in principle we ought to take account of leisure/voluntary unemployment in our welfare analysis, possibly imputing a price for leisure. In practice the value of leisure is not captured in our welfare measures.

⁸ A World Bank study by Peter Fallon and Bob Lucas that estimates a negative relationship between wages and *employment* over time is discussed in Knight and Kingdon. It seems difficult to reconcile the two results. In any case, since the model in this section is static and I have no reason to believe that liberalisation impacts upon the wage curve itself I rely primarily on the contemporaneously derived wage curve.

⁹ In practice this choice is also of some consequence since in our simulations we will see that real and nominal wages move in opposite directions.

Labour Market Information		
<i>Factor</i>	<i>Unemployment Rates</i>	<i>Wage Curve Elasticity at Benchmark</i>
Unskilled Labour	25.85%	-.149
Skilled Labour	17.94%	-.066

Source: Kingdon and Knight 1999.

Table 5

Finally, as is conventional, I assume that wages equalise across sectors and that both labour factors are mobile. I recognise this to be an unrealistic assumption – Indeed, the methodology used to derive the elasticities is only possible because there is substantial contemporaneous variation in wages across South Africa¹⁰. I also assume full in-country capital mobility. As such the results may perhaps be best thought of as capturing the “long term” ceteris paribus distributive effects of trade liberalisation rather than any transitional effects.

Government

Tariff payments by the government to the government as well as other government to government transfers have been suppressed. As is customary but lamentable in CGE models we ignore politics. We assume that government allocates fixed shares of its total (endogenous) budget to different projects.¹¹

Closure

I use what has come to be known as the “classical” closure rule. I assume a fixed savings rate for government and all consumers. Aggregate investment then adjusts to

¹⁰ In the apartheid years when movement of labour was closely controlled this assumption would be absurd, by the early 1990s, however, this assumption becomes somewhat more plausible.

¹¹ This assumption is not innocent. If we replaced the assumption with the assumption that government is required to raise a fixed revenue and so raises direct and indirect taxes to compensate for revenue losses from reduced tariffs, we would expect further distortionary effects on production than we see with the present model.

guarantee that the investment-savings identity¹² holds. Expansions or contractions in investment involve proportionate changes in investment expenditure by sector.

Welfare Analysis

I consider only income based measures of welfare. I report changes in real incomes and note changes in simple inequality measures. These capture absolute purchasing power and relative purchasing power. I do not, however, consider utility derived from the production of public goods or from leisure. Since in the model liberalisation involves a contraction of the governmental sector and for most runs a reduction in unemployment, there is implicitly a reduction in the public goods produced and a reduction in leisure. These features are ignored although measures of the extent of contraction of the governmental sector may be readily established.

Experiments

The experiments run involved gradual reductions in the tariff rates of each protected sector. Sets of runs were conducted with two different tariff measures, with and without the possibility of factor unemployment and with and without the possibility of external returns to scale in the industrial sector.

¹² For a description and discussion of this closure rule see Robinson; the short coming of the rule is that there is assumed to be a background credit market that sets interest rates such that savings equals investment. This has inter-temporal welfare implications that are not captured by our measures.

1.3 Results

The model was run with and without unemployment, and with and without increasing returns to scale in industry. There were also some runs using an upwardly sloping wage curve as found in time series data by Fallon and Lucas (1998). Each experiment involved 36 runs, with tariffs being imposed from 25% down to 0% in 5% increments for each of agriculture and capital with the other held constant. Since we have well over 100 endogenous variables in the system, each run of each experiment produces a large amount of output. However, in practice the results of the runs can be quite easily digested. The output is broadly consistent across the different experiments¹³ and within each experiment, the effects of liberalisation are quite straightforward and unambiguous. All endogenous variables move monotonically. I report here results for the most conventional runs involving constant returns to scale, with unemployment in each industry.

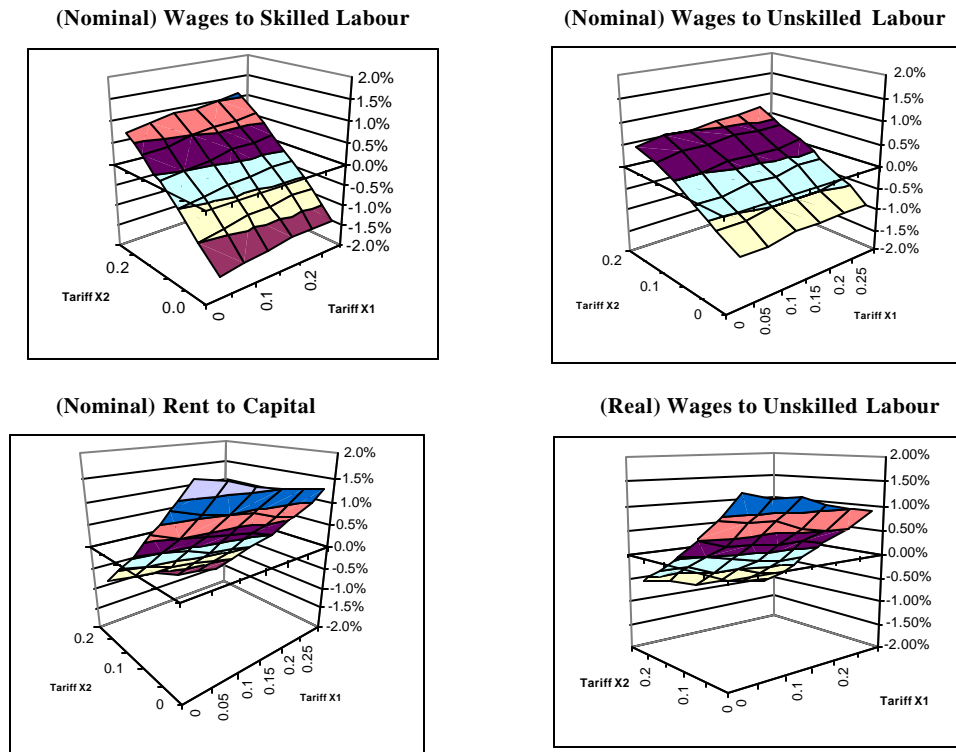
Since the experiments run involved raising and reducing tariffs on two protected sectors, the output for each endogenous variable can be easily presented in a graph that summarises the results of all 36 experiments for each endogenous variable. I leave the corresponding tables to an Appendix. I focus in turn on changes in factor prices, the consumer price indices, employment and government revenue to see their effects on changing real income as tariffs are reduced. Broadly, we will see that liberalisation results in an increase in real wages and real income. I then turn to look more closely at the income of the very poor and look at the changes in their sources of income as liberalisation takes place; doing this helps us to focus on the *ceteris paribus* assumptions upon which the punchline depends. To understand what is involved to bring these changes about I look at the change in the production structure and shifts in factor allocation that are implied by the changes. Finally, I consider the counterfactual case where the third – unprotected – good, services are protected and consider the distributive impacts of this policy.

¹³ The IRC experiments here involved a low level of external economies to scale. The choice of level was, however, otherwise arbitrary. The results for these runs involved an increase in magnitude of the effects from the CRS runs with consistent qualitative results.

Factor Prices

In keeping with Stolper-Samuelson style predictions, I find differential impacts of liberalisation on nominal returns to factors. However, the changes in nominal wages occur in just the opposite direction to what we may expect from Stolper-Samuelson. The nominal (or dollar) price of labour drops due to liberalisation, skilled labour more severely than unskilled labour. The nominal price of capital rises. These changes are illustrated in the first three panels of Figure 2.

Nonetheless although wages fall in terms of international prices, liberalisation does not lower real wages. An advantage of the general equilibrium approach that we have used is that we may simultaneously estimate changes in purchasing power along with changes in factor prices. As we see from the final panel of, the purchasing power rises at a faster rate than the fall in nominal wages, resulting in an overall rise in real wages.



Source: Model Simulations, See Table 8 and Table 9.

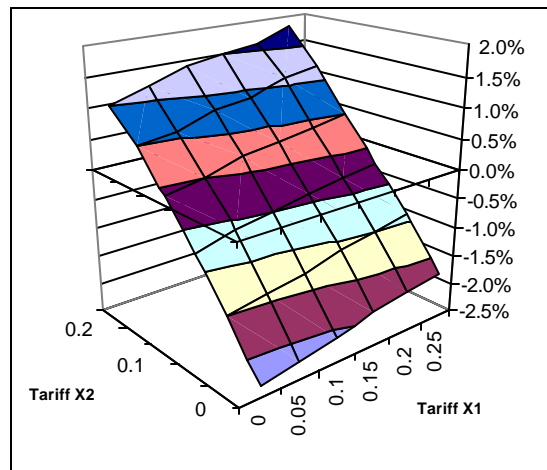
Figure 2

Note though that although real wages rise, it is still the case that real returns to capital rise at a much faster rate than do real labour wages. Complete liberalisation leads to a rise in real returns to capital of 4% as against unskilled labour's 1.4%. By the same token, increasing protectionism to 25% in both sectors reduces the real return to capital by 3.25% as against unskilled labour's fall of 1.1%,

Changes in the Consumer Price Index

The differences between nominal and real wages that we have just seen occur because liberalisation produces an unambiguous fall in the consumer price index for the poor with complete liberalisation resulting in a fall in consumer prices of some 2.3%. The price index is most sensitive to changes in tariffs on industrial goods, the most protected sector. But the fall is due not simply to the reduction in the prices consumers pay for imported goods, but also to a fall of 2.5% in each of the prices of agriculture and industry and a fall of 1% in the price of services due to increased production.

% Change in CPI of the Poor



Source: Model Simulations, See **Table 7**.

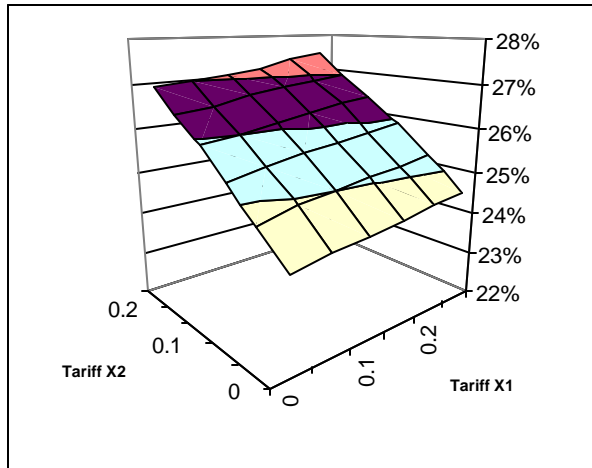
Figure 3

The graphs for the consumer price indices for the non-poor and the very poor are essentially identical.

Factor Employment

The wage curve that we use has the quality that all good (and bad) things go together. A rise in real wages results in a rise in employment among each factor group. This increase in employment results in a reduction in wages relative to what would otherwise be the case; but the net effect is a rise in both real wage income and employment. I find unemployment rates fall for the unskilled factor by about two percentage points when trade is liberalised completely. A more general picture is given in Figure 4.

Unemployment of Unskilled Labour



Source: Model Simulations. See Table 17

Figure 4

If we remove the wage curve from the model then unemployment remains constant and income gains to consumers are smaller than they would be with the negative wage curve. If we impose a *positively* sloped wage curve, corresponding to the inter-temporal employment curve result found by Fallon and Lucas we then see a rise in unemployment

Changes in Government Revenue

Theoretically it is possible that liberalization will boost imports to such an extent that the government sees an increase in tariff revenue. It is also possible that liberalization provides such a stimulus to the economy as a whole that government gains revenue from taxes on other sectors of the economy. Our simulation suggests --in support of claims from other sources¹⁴ - that in South Africa, government revenue will fall unambiguously from liberalization. Figure 5 shows that there is a marked concavity in government earnings from imposing tariffs, but if this ever reaches a maximum it would be at a considerable greater level of protectionism.

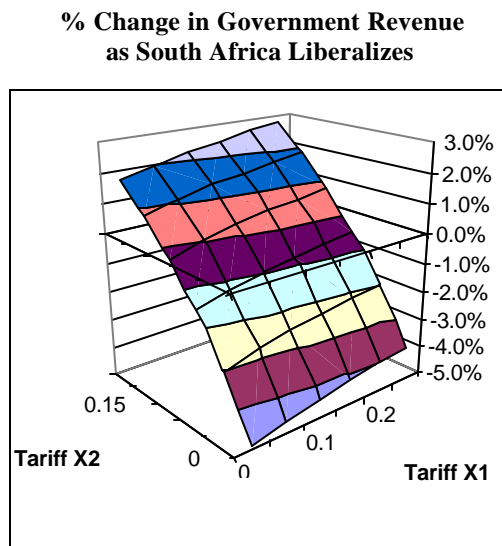


Figure 5

These cuts in government revenue imply a general fall in transfers from government to households and a reduction in the provision of government services. The latter implies a freeing up (or laying off) of workers and capital to move into production in the private sector.

Changes in Real Income

The effects then that we are seeing are quite straightforward: a fall in the consumer price index, a rise in real wages, a rise in aggregate employment. This is accompanied by a fall in government revenue, and hence a fall in direct transfers from the government to consumers alongside a general fall in the production of public goods. As we would expect –and see in Figure 6– the net result is a rise in real income for those not relying heavily on transfers from government; that is essentially all but the very poor.

Change in real income of the non-poor

Change in real income of the very poor

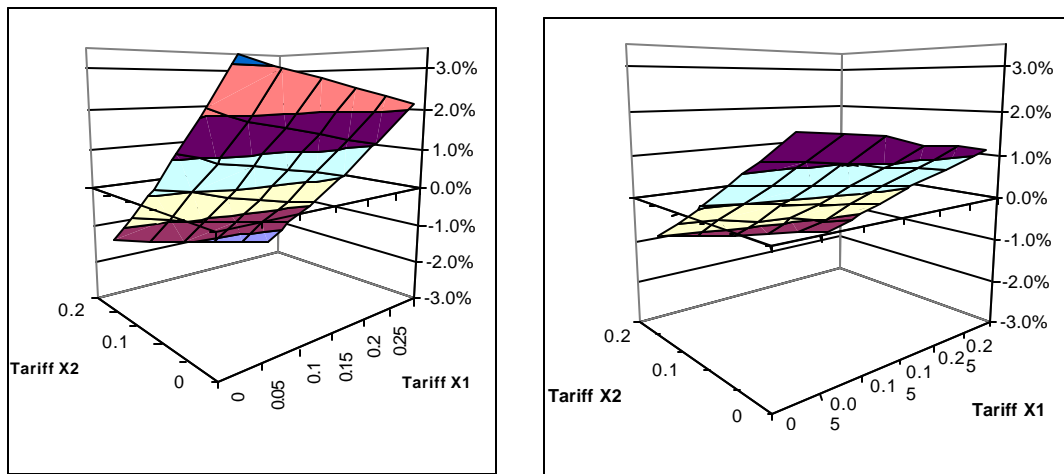


Figure 6

The non-poor and poor groups in our model each receive almost identical boosts in real income alongside liberalization. The very poor also receive a rise, albeit it more modest in real income. The change in the relative wages of the non-poor and the very poor is given by the difference in the change of relative wages of each. Income inequality is then increasing with liberalisation; this is represented in Figure 7.

¹⁴ See for example Michael Bleaney, Alan Hirsch, Merle Holden and Carolyn Jenkins, “South Africa”; chapter in Oyejide *et al.* 1999.

% Change in Income Inequality

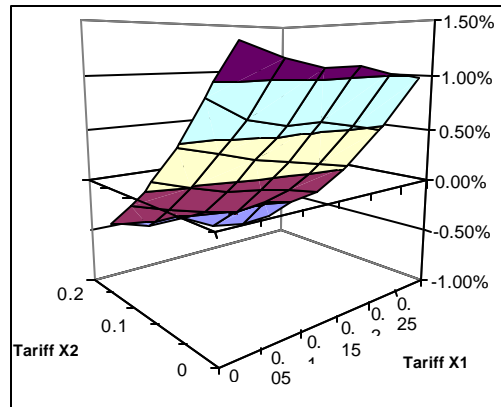


Figure 7

I now turn to see how this rise in the income of the very poor comes about as the components of the income of the poor shift.

Composition of Income of Very Poor

The rise in real wages and returns to factors and the rise in value of remittances contribute to a rise in real income for all groups. The liberalization, however, by reducing government revenue results in a fall in transfers paid by government to consumers. For non-poor and poor consumers for whom these transfers constitute a relatively small share of total income, the drop in government transfers has little impact on growth of real income. For the very poor, however, for whom government transfers are a larger share of total revenue, lost government revenue through the drop in tariffs results in a much more modest growth of real income. This mitigates somewhat the growth of their incomes. As with other agents they benefit more from the rise in real unskilled wages and increased employment, but these factor earnings constitute a smaller share of their incomes. The very poor nonetheless profit from the growth in incomes of the poor and non-poor via a rise in transfers. Figure 8 shows the change in the composition of income as industrial goods are protected. The scale on the figure is normalised such that the sum of income components equals one for base line tariffs. We see here that protection is bad for the income of the very poor; indeed as we expect from what we have seen, income rises from all categories except governmental

transfers. We see here that the fall in government transfers with liberalisation is easily offset by rises in transfers and factor returns from other sources.

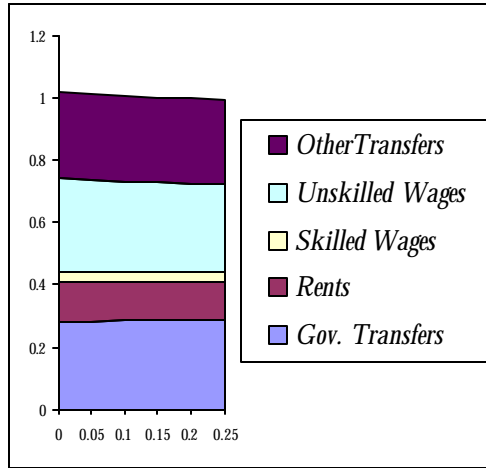


Figure 8

Nonetheless, the gains from liberalisation for the very poor are slight in comparison to gains to other groups. The very poor experienced a gain in income – although typically small – in all runs of the model that used the negatively sloping wage curve. The result is also robust to removing the link between wages and employment outright. However, if the curve is replaced by the negatively sloped employment curve estimated by Fallon and Lucas then, as we have seen, the poor stand to lose, slightly, in real terms. This loss is due to the fact that transfers from other sources, and factor wages, all of which are still increasing, are now no longer large enough to compensate for reduced transfers from government.

Changes in the Production Structure of the Economy

Effecting these changes involves quite a dramatic shift in the production structure of the South Africa economy. In particular the distributional effects result from a large shift in resources towards the agricultural sector – a much greater shift than may in fact be plausible.

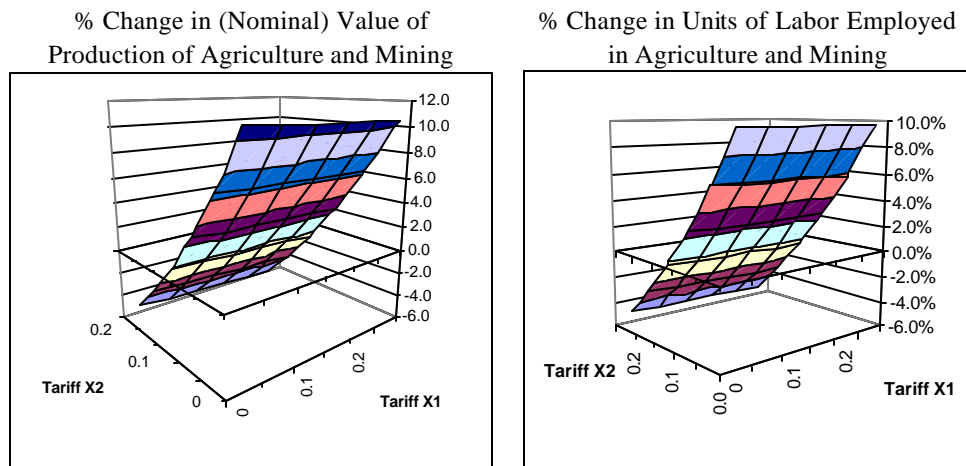


Figure 9

This itself involves the movement of large quantities of all factors into the primary sector; these are drawn in part from an increased pool of employed workers rise and in part from the laying off of workers from the public sector. The left-hand panel of Figure 9 shows the dramatic increase in the value of production of Sector 1 (the increased size in units produced is even more dramatic). We see from the panel that production in the sector is sensitive to tariffs on industry but much less so to tariffs on imported agricultural and mining goods. This follows in large part from the relatively weak reliance of the sector on agricultural and mining imports.

Protection of the Services Sector

Although the services sector is unprotected in South Africa and is unlikely to become protected it is interesting to ask how welfare would be affected were services to be

protected. Our guess may be that raising the relative price of services may benefit the non-poor -who gain a substantial part of their income from skilled labour, heavily used in the sector- relative to the poor. This turns out not to be so; the distortionary effects of protectionism dominate. The size of the services sector does increase very marginally (by .03%) as industries and consumers substitute in favour of domestic services, but the reduction in production in the other two primary and secondary industries (-3.8% and -1.3% respectively) overwhelms any income benefits accruing to the non-poor. The changes in real income are reported in Table 6 where we see that all groups lose out, with the very poor being, as before, relatively insulated from liberalisation policy.

% Change in Income from Baseline as Services are Protected

	0	0.05	0.1	0.15	0.2	0.25
<i>Non-Poor</i>	0.0%	-0.4%	-0.9%	-1.2%	-1.7%	-2.0%
<i>Poor</i>	0.0%	-0.5%	-0.8%	-1.3%	-1.6%	-2.0%
<i>Very Poor</i>	0.0%	-0.3%	-0.5%	-0.9%	-1.2%	-1.5%

Table 6

Conclusions

The punchlines of the model are that although liberalization increases income inequality between the non-poor and the very poor, it raises the income of both the poor and the non-poor of South Africa in absolute terms. The very poor are in general less affected by liberalization; they see a drop in their income from government and a rise in all other sources of income. Unless there is a significant increase in unemployment due to rising real wages, the latter are likely to outweigh the former.

To effect these changes the model requires a sharp contraction of the public sector and a large boost in production of the agricultural and mining sectors. In particular, a large share of newly employed unskilled workers and workers laid off from the public sector would need to be able to take up positions in mining and agriculture. We stress that the model assumes that these sectors have the capacity, and perhaps in the case of mining, the willingness, to expand production and that adjustment for workers shifting sectors is costless.

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3 Appendices

3.1 Formal Statement of the CGE Model

Because of the many prices, goods and versions of goods, the multiplicity of indices oftentimes makes the formal statement of CGE models difficult to follow. I hope to have made the following exposition relatively straightforward by following closely the structure of the SAM presented in Section 3.2 and by using some slightly unusual notation. To keep track of the different varieties of each commodity I use notation of the form X , \hat{X} , \vec{X} , and \bar{X} labour to denote the aggregate domestically produced good X , and the domestic, import and export market varieties of X , respectively. The arrows are intended to connote flows into and out of the economy. At a stretch the circumflex used to denote domestic goods looks a little like a wigwam. Similar hats are used for prices. A full glossary of the notation used is given immediately after the statement.

I programmed the model in Mathcad®. The code is lengthy and is not included here but is available on request along with data for replication or sensitivity analysis.

Model Equations

Domestic Production of aggregate good X_k :

$$X_k^{\frac{1}{1+g_k}} = A_k \prod_{f \in F} (F_f^{D_k})^{a_{k,f}} \prod_{k \in X} [CES^{P_k}(\hat{X}_j^{D_k}, \vec{X}_j^{D_k} | \mathbf{s}_{k,j}^S)]^{a_{k,j}}$$

with $\sum_{f \in F} a_{k,f} + \sum_{j \in X} a_{k,j} = 1$

$$X_k = CET^{P_k}(\hat{X}_k, \vec{X}_k | \mathbf{s}_k^T)$$

Allocation of Good X_k between non-traded and for-export varieties:

$$\hat{X}_k = CET^D((\hat{p}_k \hat{X}_k + \vec{p}_k \vec{X}_k), \hat{p}_k, \vec{p}_k, | \mathbf{s}_k^T)$$

$$\vec{X}_k = CET^D((\hat{p}_k \hat{X}_k + \vec{p}_k \vec{X}_k), \vec{p}_k, \hat{p}_k, | \mathbf{s}_k^T)$$

Demands for Factor inputs by sector j :

$$F_f^{D_k} = \frac{\mathbf{a}_{k,f}}{p_k} [\hat{p}_k \hat{X}_k + \bar{p}_k \bar{X}_k] \quad \forall k \in X, f \in F$$

Demands for Intermediate Inputs of good j by sector k :

$$\begin{aligned} \hat{X}_j^{D_k} &= CES^{D_k} [\mathbf{a}_{k,j} (\hat{p}_k \hat{X}_k + \bar{p}_k \bar{X}_k), \hat{p}_j, \bar{p}_j (1 + \bar{t}_j)] \quad \forall k, j \in X \\ \bar{X}_j^{D_k} &= CES^{D_k} [\mathbf{a}_{k,j} (\hat{p}_k \hat{X}_k + \bar{p}_k \bar{X}_k), \bar{p}_j (1 + \bar{t}_j), \hat{p}_j] \quad \forall k, j \in X \end{aligned}$$

Consumer i 's Income:

$$Y_i = \sum_{f \in F} \bar{e}_{i,f} \times p_f \times (1 - u_f) + \sum_{z \in Z^+} T_{z,i} \quad \forall i \in I$$

Consumer Demands:

$$\begin{aligned} \hat{X}_j^{D_i} &= CES^{D_i} [Y_i, \hat{p}_j, \bar{p}_j (1 + \bar{t}_j)] \quad \forall i \in I, j \in X \\ \bar{X}_j^{D_i} &= CES^{D_i} [Y_i, \bar{p}_j (1 + \bar{t}_j), \hat{p}_j] \quad \forall i \in I, j \in X \end{aligned}$$

$$F_f^{D_i} = \frac{\mathbf{a}_{i,f} Y_i}{p_f} \quad \forall i \in I$$

Consumer Savings:

$$s_i = \mathbf{a}_{i,s} Y_i \quad \forall i \in I$$

Government Revenue:

$$Y_G = \sum_{i \in I} Y_i \times t_i + \sum_{j \in X} p_j X_j \times t_j + \sum_{(j \in X)(z \in Z/G)} \sum \bar{p}_j \bar{X}_j^{D_z} \times \bar{t}$$

Government Demands:

$$\hat{X}_j^{D_G} = \frac{\mathbf{a}_{G,\hat{X}_j} Y_G}{\hat{p}_j}, \quad \bar{X}_j^{D_G} = \frac{\mathbf{a}_{G,\bar{X}_j} Y_G}{\bar{p}_j}, \quad F_f^{D_G} = \frac{\mathbf{a}_{G,f} Y_G}{p_f}$$

Government Savings:

$$s_G = \mathbf{a}_{G,s} Y_G$$

Transfers are handled with fixed coefficients. Transfers from (but not to) the rest of the world are fixed (in nominal terms).

$$T_{z,z'} = \mathbf{a}_{z,z'} Y_z \quad \forall z \in Z, z' \in Z^+$$

$$T_{w,z} = \bar{T}_{w,z} \quad \forall z \in Z$$

Matching equation:

$$u_f = \frac{1}{1 + e^{a + b \times \frac{p_f}{CPI_1}}}$$

Consumer Price Indices:

$$CPI_i = \frac{\sum_{j \in X} a_{i,j} \times p_j^i}{\sum_{j \in X} a_{i,j}}, \quad \text{with} \quad p_j^i = \frac{\hat{p}_j X_j^{D_j} + \bar{p}_j \bar{X}_j^{D_j}}{CES^i(X_j^{D_j}, \bar{X}_j^{D_j})}, p_j^i$$

Equilibrium Conditions:

The conditions that follow may be thought of as accounting identities. They ensure that the sum of row j in the SAM is equal to the sum of column j , or in the cases of government revenue and the trade balance, that the sum of a set of rows equals the sum of a set of columns. For clarity of exposition I present the conditions here in the order of the columns of the SAM.

[Columns 1-3] Zero Profit Conditions

$$\sum_{f \in F} p_f F_f^{D_k} + \sum_{j \in X} (\hat{p}_j \hat{X}_j^{D_k} + \bar{p}_j (1 + \bar{t}_j) \bar{X}_j^{D_k}) = \left(\hat{p}_k \sum_{z \in Z} \hat{X}_k^{D_z} + \bar{p}_k \bar{X}_k \right) \times (1 - t_k) \quad \forall k \in X$$

Domestic Goods Market Clearance Conditions

$$\hat{X}_k = \sum_{z \in Z} \hat{X}_k^{D_z} \quad \forall k \in X$$

[Columns 4-6] Factor Market “Clearance” Conditions

$$\sum_{z \in Z} F_f^{D_z} = (1 - u_f) \times \sum_{i \in I} \bar{e}_{i,f} \quad \forall f \in F$$

[Columns 7-9] Consumer Income/Expenditure identities

$$Y_i (1 - t_i) = \sum_{k \in X} (\hat{p}_k \hat{X}_k^{D_i} + \bar{p}_k (1 + \bar{t}_k) \bar{X}_k^{D_i}) + \sum_{f \in F} F_f^{D_i} + \sum_{z \in Z^+} T_{i,z} + s_i \quad \forall i \in I$$

[Column 9] Government Income/Expenditure identities

$$Y_G = \sum_{k \in X} (\hat{p}_k \hat{X}_k^{D_G} + \bar{p}_k \bar{X}_k^{D_G}) + \sum_{f \in F} F_f^{D_G} + \sum_{z \in Z^+} T_{G,z} + s_G$$

[Column 11] Investment = Savings Identity

$$\sum_{z \in Z} s_z + e_{C,K} p_K = \sum_{k \in X} (\hat{p}_k \hat{X}_k^{D_C} + \bar{p}_k (1 + \bar{t}_k) \bar{X}_k^{D_C})$$

[Columns 12-13] Balance of Payments Condition

$$\sum_{k \in X} \bar{p}_k \bar{X}_k + \sum_{z \in Z} T_{w,z} = \sum_{k \in X} \sum_{z \in Z} \bar{p}_k \bar{X}_k^{D_{zj}} + \sum_Z T_{z,w}$$

Notation

Sets

- F the set of all factors (capital, skilled and unskilled labour), subscripted by f .
- I the set of all consumers (non-poor, poor, very poor), subscripted by i .
- X the set of goods/industries (primary, secondary, tertiary).
NOTE: j and k are used interchangeably to subscript elements of X.
- G a degenerate set: the government, subscripted by G .
- W a degenerate set: the world, subscripted by w .
- C the capital account, subscripted by C .
- Z the set of all domestic actors = $X \cup I \cup G \cup C$, subscripted by z or z' .
- Z⁺ the set of all actors = $Z \cup W$, subscripted by z or z' .

Prices

Endogenous prices:

- $\hat{p}_k \quad \forall k \in X$: Domestic prices of non-traded variety of good k .
 $p_f \quad \forall f \in F$: Factor prices of factor f .
 $p_j^i \quad \forall i \in I, j \in X$: Consumer price for aggregate good j .
 $CPI_i \quad \forall i \in I$: Consumer Price Index for Consumer i .

Exogenous prices:

- $\bar{p}_k \quad \forall k \in X$: World prices of export variety of good k .
 $\bar{p}_k \quad \forall k \in X$: World prices of import variety of good k .

Numéraire: the exchange rate

Policy Parameters

- t_i, t_j, \bar{t}_j Direct taxes on consumers, producers and tariffs on imports.

Other Endogenous Variables

- $X_j \quad \forall j \in X$: Domestic production of aggregate good j .
 $\bar{X}_j \quad \forall j \in X$: Exports of good j .
 $\hat{X}_j^{D_k}, \hat{X}_j^{D_i}, \hat{X}_j^{D_G}$ Demand for (domestic) good j , by industry k , consumer i or government.
 $\bar{X}_j^{D_k}, \bar{X}_j^{D_i}, \bar{X}_j^{D_G}$ Demand for (imported) good j , by industry k , consumer i or government.
 $\hat{X}_j^{D_G}, \bar{X}_j^{D_G}$ Investments of domestic and imported variants of good j .
 $F_f^{D_k}, F_f^{D_i}, F_f^{D_G}$ Demand for Factor f by industry k , consumer i or the government.
 $T_{z,z'}$ Transfers from agent $z \in Z^+$ to agent $z' \in Z^+$
 $Y_i \quad \forall i \in I$: Income of Agent i
 Y_G Government Revenue
 $s_z \quad \forall z \in Z$: Savings of agent z .
 $u_f \quad \forall f \in F$: Unemployment rate within factor f .

Other exogenous parameters

- $S_{k,j}^S, S_{k,i}^S$ Elasticity of substitution over imported / domestic varieties of good j for industry k , or consumer i .
 S_k^T Elasticity of transformation for industry k between domestic market and for-export varieties of good X_k .
 g_k A measure of the external returns to scale of a sector. $g=0$ corresponds to CRS, $g>0$ corresponds to IRS. I set $g=0$ for all sectors for all but one run.

$\bar{e}_{i,f}$

Agent i 's endowment of factor f . ($e_{c,k}$ represents the capital earnings that are placed into the capital account)

Functions

 $CES^{P_k}(X_1, X_2 | \mathbf{S})$

Production function for the “aggregate” good of type k using inputs of X_1 and X_2 . Such a form is used for creating aggregate intermediate goods from imported and domestic inputs and for creating aggregate consumption goods for consumers.

 $CES^{D_i}[Y, p_1, p_2 | \mathbf{S}^S]$

CES demands of agent i for the good corresponding to p_1 , given based (share of) income or revenue Y allocated to two goods with consumer (or producer) prices p_1 and p_2 . Inverting the order of the p_1 and p_2 arguments denotes demands for good 2.

 $CET^P(\hat{X}, \bar{X} | \mathbf{S}^T)$

Constant elasticity of transformation production function to constrain the quantities of export and domestic market varieties that may be made from the input of an aggregate good X .

 $CET^D(Y, p_1, p_2 | \mathbf{S}^T)$

CET demand for the good corresponding to p_1 , given revenue Y .

NOTE: There is a slight abuse of notation in the shorthand writing of these functions. I indicate the good to which demand corresponds by the placement or the good's related price. Strictly, unless the goods enter symmetrically, the function name itself should alter to indicate demands for different goods.

Calibrated parameters

Intercept and share parameters are calibrated for all production functions and for the unemployment equation parameters. Most of these are suppressed from the statement of the model above except for the A_k terms and all the α terms.

3.2 SAMs: Before and After

3.2 a. Base Year SAM

	Sectors			Factors			Agents			Capital Account	Rest of the World		Total	
	Primary	Industry	Services	Capital	Skilled Labour	Unskilled Labour	Non-Poor	Poor	Very Poor	Government	Capital Account	Exports	Transfers	
Primary	0.80	16.00	0.30				9.00	1.43	0.17	0.30		38.21		66.21
Industry	15.00	100.00	25.60				65.40	7.06	0.84	11.50	31.25	26.30		282.95
Services	7.80	38.50	59.00				76.50	6.43	0.77	6.20	0.97	12.00		208.17
Capital	21.00	44.20	46.80							22.00				134.00
Skilled	3.30	19.00	42.70							25.30				90.30
Unskilled	15.00	31.00	19.80				4.00			18.90				88.70
Non-Poor				50.10	88.30	73.30	1.40			8.30			0.41	221.81
Poor				1.98	1.92	14.65	1	0.09	0.01	2.15			0.08	21.88
Very Poor				0.32	0.08	0.75	0.4	0.27	0.03	0.75			0.01	2.61
Taxes	-0.44	2.51	3.72	16.60			46.70	5.47	0.65		24.27			99.17
Tariffs	0.44	3.14	0.40				0.80	0.07	0.01		1.22			6.45
Capital Account				65.00			5.40	0.09	0.01					70.50
Imports of X1	0.20	7.80	0.05				0.28	0.02	0.00					8.35
Imports of X2	3.00	18.00	5.00				5.46	0.48	0.06	2.18	8.84			43.02
Imports of X3	0.10	2.80	4.80				5.37	0.47	0.06	0.52				14.12
Transfers to ROW							0.10			7.52	3.90			11.52
Total	66.21	282.95	208.17	134.00	90.30	88.70	221.8	21.88	2.61	105.62	70.50	76.51	0.50	

SOURCE: 1992 South African SAM.

3.2 b. Zero Tariff SAM

	Sectors			Factors			Agents			Capital Account	Rest of the World		Total	
	Primary	Industry	Services	Capital	Skilled Labour	Unskilled Labour	Non-Poor	Poor	Very Poor	Government	Capital Account	Exports	Transfers	
Primary	0.87	16.16	0.31				9.04	1.44	0.17	0.29		44.48		72.75
Industry	16.21	100.59	25.99				63.86	6.9	0.82	11.07	31.83	30.03		287.31
Services	8.57	39.11	60.15				77.34	6.50	0.77	5.91	0.99	12.84		212.18
Capital	23.07	44.88	47.70							20.93				136.58
Skilled	3.63	19.29	43.52							24.07				90.51
Unskilled	16.48	31.48	20.18				4.04			17.98				90.15
Non-Poor				51.07	88.50	74.50	1.41			7.90			0.41	223.78
Poor				2.02	1.92	14.89	1.01	0.09	0.01	2.04			0.08	22.07
Very Poor				0.33	0.08	0.76	0.40	0.27	0.03	0.71			0.01	2.598
Taxes	-0.48	2.56	3.47	16.92			47.11	5.52	0.65	0.00	24.72			100.46
Tariffs	0.00	0.00	0.00				0.00	0.00	0					0.00
Capital Account				66.25			5.45	0.09	0.01	0.00				71.80
Imports of X1	0.24	8.58	0.06				0.34	0.02	0.002	0.00				9.24
Imports of X2	4.04	21.85	5.93				8.42	0.75	0.09	1.94	10.29			53.31
Imports of X3	0.11	2.83	4.88				5.26	0.46	0.05	0.48				14.08
Transfers to ROW							0.10	0.00	0	7.15	3.97			11.22
Total	72.75	287.32	212.18	136.58	90.51	90.15	223.8	22.07	2.598	100.46	71.80	87.35	0.50	

SOURCE: Model Simulations

3.2 c. Guide to Reading the SAMs

The figure below acts as a map for reading the entries in the SAMs above. Any entry in the table of the form SAM_{ij} corresponds to a payment to column *j* from row *i*. The entries below should help with interpreting what these payments mean.

	Sectors			Factors			Agents			Capital Account	Rest of the World		Total	
	Primary <i>l</i>	Industrial <i>1</i>	Services <i>2</i>	Capital	Skilled Labour	Unskilled Labour	Non-Poor	Poor	Very Poor	Government	Capital Account	Exports	Transfers	
Primary	DOMESTIC INTERMEDIARY GOODS						CONSUMER EXPENDITURE ON DOMESTIC GOODS			GOVERNMENT EXPENDITURE	INVESTMENT, (INCLUDING EXPENDITURE ON IMPORTED INVESTMENT GOODS)	EXPORTS		RECEIPTS
Industrial							FACTOR INPUTS TO PRODUCTION					TRANSFERS BETWEEN AGENTS		
Services						WAGES RECEIVED BY AGENTS			DIRECT AND INDIRECT TAXES	INVESTMENT, (INCLUDING EXPENDITURE ON IMPORTED INVESTMENT GOODS)		REMITTANCES	INCOME	
Capital						TARIFF REVENUE								GOV. REV.
Skilled	SAVINGS													
Unskilled	SAVINGS													
Non-Poor	SAVINGS													
Poor	SAVINGS													
Very Poor	SAVINGS													
Taxes	SAVINGS													
Tariffs	SAVINGS													
Capital Account	SAVINGS													
Imports of X1	IMPORTED INPUTS TO PRODUCTION						CONSUMER EXPENDITURE ON IMPORTS							FOREIGN EXCHANGE EXPENDITURE
Imports of X2							REMITTANCES SENT ABROAD							
Imports of X3	SAVINGS													
Transfers to ROW	SAVINGS													
Total	COSTS OF PRODUCTION	TOTAL FACTOR INCOME			EXPENDITURE BY CONSUMERS			GOV EXP	FOREIGN EXCHANGE EARNINGS					

3.3 Results of CGE experiments in tabular form.

Prices

% Changes in CPI of the Poor

		Tariff on Agriculture					
		0	0.05	0.1	0.15	0.2	0.25
Tariff on Industry	0	-2.3%	-2.2%	-2.1%	-1.9%	-1.8%	-1.7%
	0.05	-1.5%	-1.4%	-1.3%	-1.1%	-1.0%	-0.9%
	0.1	-0.8%	-0.6%	-0.5%	-0.4%	-0.3%	-0.2%
	0.15	-0.1%	0.0%	0.2%	0.3%	0.4%	0.5%
	0.2	0.5%	0.6%	0.8%	0.9%	1.1%	1.2%
	0.25	1.0%	1.2%	1.4%	1.5%	1.6%	1.8%

Table 7

% Changes in Nominal Unskilled Wages

		Tariff on Agriculture					
		0	0.05	0.1	0.15	0.2	0.25
Tariff on Industry	0	-0.9%	-0.9%	-0.8%	-0.8%	-0.8%	-0.8%
	0.05	-0.6%	-0.6%	-0.5%	-0.5%	-0.5%	-0.4%
	0.1	-0.3%	-0.3%	-0.2%	-0.2%	-0.1%	-0.1%
	0.15	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%
	0.2	0.2%	0.3%	0.3%	0.4%	0.4%	0.4%
	0.25	0.4%	0.5%	0.5%	0.6%	0.6%	0.7%

Table 8

% Change in Real Unskilled Wages

		Tariff on Agriculture					
		0	0.05	0.1	0.15	0.2	0.25
Tariff on Industry	0	1.4%	1.3%	1.3%	1.1%	1.0%	0.9%
	0.05	0.9%	0.8%	0.8%	0.6%	0.5%	0.5%
	0.1	0.5%	0.3%	0.3%	0.2%	0.2%	0.1%
	0.15	0.1%	0.0%	-0.1%	-0.2%	-0.3%	-0.3%
	0.2	-0.3%	-0.3%	-0.5%	-0.5%	-0.7%	-0.8%
	0.25	-0.6%	-0.7%	-0.9%	-0.9%	-1.0%	-1.1%

Table 9

Changes in real income.

Note that the differences in the changes in real income between the non-poor and the poor are so slight that a second digital place has to be admitted to observe differences between them! Changes in the income of the very poor is more modest. The inequality measure graphed in the text is the difference between Table 10 and Table 12.

% Change in Real Income of the Non-Poor

		Tariff on Agriculture					
		0	0.05	0.1	0.15	0.2	0.25
Tariff on Industry	0	3.16%	2.95%	2.75%	2.55%	2.35%	2.15%
	0.05	2.16%	1.86%	1.66%	1.46%	1.27%	1.07%
	0.1	1.17%	0.88%	0.68%	0.49%	0.30%	0.11%
	0.15	0.19%	0.00%	-0.29%	-0.47%	-0.66%	-0.85%
	0.2	-0.68%	-0.86%	-1.14%	-1.33%	-1.51%	-1.69%
	0.25	-1.45%	-1.72%	-1.90%	-2.17%	-2.35%	-2.53%

Table 10

% Change in Real Income of the Poor

		Tariff on Agriculture					
		0	0.05	0.1	0.15	0.2	0.25
Tariff on Industry	0	3.23%	3.05%	2.85%	2.55%	2.37%	2.18%
	0.05	2.13%	1.95%	1.76%	1.48%	1.29%	1.11%
	0.1	1.14%	0.86%	0.69%	0.51%	0.33%	0.16%
	0.15	0.17%	-0.01%	-0.28%	-0.45%	-0.62%	-0.80%
	0.2	-0.70%	-0.87%	-1.13%	-1.29%	-1.56%	-1.74%
	0.25	-1.46%	-1.72%	-1.98%	-2.13%	-2.30%	-2.57%

Table 11

% Change (Over Baseline) in Real Income of the Very Poor

		Tariff on Agriculture					
		0	0.05	0.1	0.15	0.2	0.25
Tariff on Industry	0	1.9%	1.8%	1.7%	1.4%	1.3%	1.2%
	0.05	1.3%	1.2%	1.1%	0.8%	0.7%	0.6%
	0.1	0.7%	0.5%	0.4%	0.3%	0.2%	0.1%
	0.15	0.1%	0.0%	-0.2%	-0.3%	-0.4%	-0.5%
	0.2	-0.5%	-0.6%	-0.7%	-0.8%	-1.1%	-1.2%
	0.25	-1.0%	-1.2%	-1.3%	-1.4%	-1.6%	-1.8%

Table 12

% Change in Nominal Value of Production of Primary Goods

		Tariff on Agriculture					
		0	0.05	0.1	0.15	0.2	0.25
Tariff on Industry	0	9.9%	9.8%	9.8%	9.8%	9.8%	9.8%
	0.05	6.0%	5.9%	5.9%	5.8%	5.8%	5.8%
	0.1	2.6%	2.6%	2.5%	2.5%	2.5%	2.4%
	0.15	-0.3%	-0.4%	-0.4%	-0.4%	-0.5%	-0.5%
	0.2	-2.8%	-2.9%	-2.9%	-3.0%	-3.0%	-3.0%
	0.25	-5.1%	-5.1%	-5.2%	-5.2%	-5.3%	-5.3%

Table 13

% Change in Nominal Value of Industrial Output

		Tariff on Agriculture					
		0	0.05	0.1	0.15	0.2	0.25
Tariff on Industry	0	1.5%	1.2%	0.8%	0.5%	0.2%	-0.1%
	0.05	1.2%	0.8%	0.4%	0.1%	-0.2%	-0.5%
	0.1	0.8%	0.4%	0.1%	-0.2%	-0.5%	-0.8%
	0.15	0.5%	0.1%	-0.2%	-0.5%	-0.8%	-1.1%
	0.2	0.1%	-0.2%	-0.5%	-0.8%	-1.1%	-1.4%
	0.25	-0.2%	-0.5%	-0.9%	-1.1%	-1.4%	-1.7%

Table 14

% Change in Nominal Value of Services

		Tariff on Agriculture					
		0	0.05	0.1	0.15	0.2	0.25
Tariff on Industry	0	1.9%	1.8%	1.6%	1.4%	1.3%	1.1%
	0.05	1.3%	1.1%	1.0%	0.8%	0.7%	0.5%
	0.1	0.7%	0.5%	0.4%	0.2%	0.1%	0.0%
	0.15	0.2%	0.0%	-0.2%	-0.3%	-0.5%	-0.6%
	0.2	-0.4%	-0.5%	-0.7%	-0.8%	-1.0%	-1.1%
	0.25	-0.8%	-1.0%	-1.2%	-1.3%	-1.4%	-1.6%

Table 15

% Change in Unemployment of Unskilled Labour over Baseline

		Tariff on Agriculture					
		0	0.05	0.1	0.15	0.2	0.25
Tariff on Industry	0	-6.8%	-6.4%	-6.0%	-5.6%	-5.2%	-4.8%
	0.05	-4.4%	-3.7%	-3.3%	-2.9%	-2.5%	-2.1%
	0.1	-2.1%	-1.4%	-1.0%	-0.6%	-0.2%	0.2%
	0.15	0.2%	0.6%	1.0%	1.7%	2.1%	2.5%
	0.2	2.1%	2.5%	3.3%	3.7%	4.1%	4.4%
	0.25	4.1%	4.4%	4.8%	5.2%	6.0%	6.4%

Table 16

% Change in Unemployment Rate for Unskilled Labour ($U_{t1} - U_{t0}$)

		Tariff on Agriculture					
		0	0.05	0.1	0.15	0.2	0.25
Tariff on Industry	0	-1.8%	-1.7%	-1.6%	-1.5%	-1.4%	-1.3%
	0.05	-1.2%	-1.0%	-0.9%	-0.8%	-0.7%	-0.6%
	0.1	-0.6%	-0.4%	-0.3%	-0.2%	-0.1%	0.1%
	0.15	0.1%	0.2%	0.3%	0.5%	0.6%	0.7%
	0.2	0.6%	0.7%	0.9%	1.0%	1.1%	1.2%
	0.25	1.1%	1.2%	1.3%	1.4%	1.6%	1.7%

Table 17

% Changes in Each Source of Real Income of the Very Poor over Free Trade Situation as Industrial Tariffs Introduced

Sources of Income	Tariff on Industry					
	0	0.05	0.1	0.15	0.2	0.25
Gov. Real Transfers	0.0%	1.1%	2.0%	2.6%	3.0%	3.4%
Real Rents	0.0%	-1.4%	-2.7%	-3.9%	-5.0%	-5.9%
Skilled Real Wages	0.0%	-0.8%	-1.6%	-2.3%	-3.0%	-3.7%
Unskilled Real Wages	0.0%	-1.3%	-2.5%	-3.7%	-4.7%	-5.6%
Other (Real) Transfers	0.0%	-1.0%	-2.0%	-2.9%	-3.8%	-4.5%
Total Change in Real Income	0.0%	-0.6%	-1.1%	-1.7%	-2.3%	-2.8%

Table 18