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The Welfare Impacts of National and International Agricultural Efficiency Gains – A South African Case Study

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PROVIDE PROJECT

The Provincial Decision-making Enabling Project

Overview

The Provincial Decision-Making Enabling (PROVIDE) Project aims to facilitate policy design by supplying policymakers with provincial and national level quantitative policy information. The project entails the development of a series of databases (in the format of Social Accounting Matrices) for use in Computable General Equilibrium models.

The National and Provincial Departments of Agriculture are the stakeholders and funders of the PROVIDE Project. The research team is located at Elsenburg in the Western Cape.

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The Welfare Impacts of National and International Agricultural Efficiency Gains – A South African Case Study[1]

Abstract

Ongoing agricultural and food commodity price declines associated with efficiency gains in agricultural production, both domestically and internationally, can have important welfare effects for a country. The fact that consumers can buy cheaper imported and/or domestically produced foodstuffs has various spin-off effects in the economy. However, as with any economic shock there are winners and losers, and hence it is important to gain an understanding of the economy-wide effects, specifically in terms of the employment effects and the income- and substitution effects associated with relative price changes in the economy. In this paper the impact of domestic and international efficiency changes in the agricultural sector is modelled using a South African Computable General Equilibrium model with highly disaggregated food and agricultural sectors. The results indicate that while consumers gain from both domestic and international efficiency gains, domestic agricultural producers face a contraction in output when world trade prices decline as a result of international efficiency gains. Efficiency gains have different welfare impacts upon different types of household, with rural households not gaining as much as urban households due to job losses in the agricultural sector that offset welfare gains associated lower prices.

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Table of Contents

Executive Summary ... iii
1. Introduction ... 1
2. Technical change and welfare effects ... 2
2.1. Theoretical underpinnings ... 2
2.2. The green revolution and technical change in South African agriculture ... 6
3. Computable general equilibrium model and data ... 8
3.1. CGE model ... 8
3.2. Data ... 9
4. Policy analysis ... 10
4.1. Policy scenarios ... 10
4.2. Model closure rules ... 11
4.3. Results and analyses ... 12
4.3.1. Domestic efficiency gains (SIMSET1) ... *12*
4.3.2. International technical change (SIMSET2) ... *15*
4.3.3. Combined domestic and international efficiency gains (SIMSET3) ... *17*
5. Conclusions ... 20
6. References ... 22
7. Appendix ... 23

List of Figures

Figure 1: A two-tier production structure ... 5
Figure 2: Economy-wide factor income effects (*YF*) (*sim14*, percentage changes) ... 15
Figure 3: Economy-wide factor income effects (*YF*) (*sim24*, percentage changes) ... 17
Figure 4: Economy-wide factor income effects (YF) (*sim34*, percentage changes) ... 19
Figure 5: Welfare effects by household groups (*sim31*-*sim35*, percentage changes) ... 20

List of Tables

Table 1: TFP growth estimates for South Africa (1960 – 1999) (percentage change) ... 7
Table 2: Description of simulation sets and simulations ... 11
Table 3: Production and commodity price effects (*sim14*, percentage changes) ... 13
Table 4: Commodity flows (*sim14*, percentage changes) ... 14
Table 5: Factor demand (*FD*) effects (*sim14*, percentage changes) ... 15
Table 6: Commodity flows (*sim24*, percentage changes) ... 16
Table 7: Factor demand (*FD*) effects (*sim24*, percentage changes) ... 17
Table 8: Commodity flows (*sim34*, percentage changes) ... 18
Table 9: Domestic agricultural production (*QX*) (*sim31*-*sim35*, percentage changes) ... 18
Table 10: Factor demand (*FD*) effects (*sim34*, percentage changes) ... 19
Table 11: Behavioural relationships for the standard CGE model presented within a SAM framework ... 23
Table 12: SAM Accounts for this study ... 24

Executive Summary

Efficiency gains in agricultural production have been highlighted internationally as one of the main driving forces behind the ongoing reductions in global agricultural and food prices. In South Africa there are frequent calls for improvements in agricultural efficiency in agriculture in the interest of greater competitiveness, especially in the light of the recent exchange rate appreciation and the move towards freer trade. Productivity gains allow agricultural producers to produce a unit of output using fewer inputs than before and hence producer prices decline, which leads to greater competitiveness. Productivity growth has various spin-off effects in the economy, some positive and some negative. In this paper the aim is to explore these various indirect effects in a Computable General Equilibrium model to make a sound assessment of the overall welfare effects of agricultural efficiency gains. The model is calibrated with a Social Accounting Matrix for South Africa for 2000 with highly disaggregated agricultural/food activity and commodity accounts.

Reductions in agricultural producer prices feed through directly to lower agricultural purchaser prices, while food commodity prices decline indirectly since food industries benefit from cheaper agricultural commodities purchased as intermediate inputs. Simulation results of a 2% efficiency gain in domestic agriculture relative to international agriculture indicate that agricultural prices are likely to drop by between 0.31% and 4.68%, and food prices by between 0.05% and 1.50% for the various commodities. Such food and agricultural commodity price reductions constitute an important welfare gain for consumers. Consumers also gain from improved international efficiency due to the reduction in prices of imported agricultural and food commodities.

The price movements associated with domestic agricultural efficiency gains cause agricultural and food commodity imports to fall by 1.96% and 0.67% respectively, while it also leads to an export drive with agricultural and food commodity exports increasing by 3.04% and 1.37% respectively. As a result of increased demand for domestically produced goods overall agricultural output increases. The opposite effect occurs in the event that South Africa does not make sufficient technological progress and international agricultural industries experience relative efficiency gains. A 2% decline in international agricultural prices coupled with a 1% decline in international food prices leads to an increase in demand for imported agricultural and food commodities (1.49% and 1.02% respectively), while domestic producers lose some of their export market share (declines of 1.85% and 1.46% respectively), thus leading to a contraction in agricultural and food output.

Domestic agricultural efficiency gains also have some negative effects in the agricultural sector. A concern often raised is the job losses associated with such efficiency gains. The

losers are typically low-income farm workers or small-scale subsistence farmers who struggle to compete. The simulation results of a 2% domestic efficiency gain suggest that the South African agricultural sector may shed between 0.84% and 2.44% of its workers. However, it is important not to view this in isolation. The efficiency gains experienced in agriculture lead to increased economic activity and factor demand elsewhere in the economy. In fact, the results indicate that overall returns to factors rise by between 0.27% and 0.34%. The contraction in agricultural output due to a relative increase in international efficiency, i.e. if South Africa does not make sufficient technological progress, also has a negative employment effect, with employment declining by between 0.52% and 1.32% in agricultural industries and 0.39% and 0.65% in food industries. The impact on overall factor returns is very small, with changes ranging from –0.07% to 0.10%.

The final set of simulations explores the impact of combined domestic and international efficiency gains. The impact on imports, exports and food and agricultural production levels depend on the relative magnitudes of the domestic or international efficiency gains. For a 2% domestic efficiency gain combined with a 2% (1%) international agricultural (food) commodity price decline, agricultural employment declines by between 2.14% and 3.08%, while employment in the food industry declines by between 0.64% and 1.48%. However, the increase in demand for factors in other industries counteracts this move and overall employment and factor returns increase by between 0.19% and 0.42%.

The combined effects of lower domestic and international prices, and higher factor (household) incomes have positive welfare effects for all households. However, an analysis of the distribution of the welfare gains shows that rural households do not gain as much as their urban counterparts, mainly because agricultural job losses are concentrated in rural areas. Although the job losses are made up for in other industries it is important that government consider relief policies for the interim adjustment period. These may include retraining workers for work in other industries or assisting with the creation of job opportunities in rural areas. There are also some concerns about the distributional effect of agricultural efficiency gains, with low-income households gain relatively less than high-income households. Policies may have to be put in place to prevent inequality to increase further, especially in South Africa where the distribution of income and opportunities are already skewed.

1. Introduction

A large proportion of the ongoing reductions in global food prices is attributable to the efficiency gains associated with various 'green revolutions'. Unfortunately the welfare gains associated with such productivity growth are unevenly distributed, with many African states reaping relatively few benefits. One possible reason for this is the failure of African agriculture to retain its relative competitiveness in global agricultural and food markets, and hence, the consumer welfare gains associated with reductions in consumer prices are largely offset by the producer welfare losses associated with reductions in producer prices.

As the role-players in the agricultural sector policymakers and farmers have to face the challenges of rapid changes in technology, domestic and international prices and consumer demand patterns. Fortunately advancements in microeconomic theory and empirical methods have enabled researchers to simulate and evaluate the impact of such economic shocks on the agricultural industry as well as the economy as a whole. The analyses reported in this paper explore how changes in domestic and international agricultural and food processing efficiency will impact upon the welfare of households and the profitability of agricultural and food industries in South Africa. As a small economy South Africa is a price-taker on export markets, and efficiency gains in foreign agricultural industries thus affect the prices faced by domestic importers and exporters. These impact on domestic producers through changes in output prices, and on domestic consumers through changes in purchaser prices.

Estimates of the socio-economic impacts of domestic and international efficiency changes are generated with a computable general equilibrium (CGE) model for South Africa. The CGE model is calibrated with a Social Accounting Matrix (SAM) with highly disaggregated food and agricultural sectors. The scenarios simulated focus on various dimensions of international and domestic technology change.

The paper is structured as follows. Section 2 gives a theoretical overview of technical change and its welfare effects via employment, prices and output levels within the context of the CGE model used in the study. Section 3 describes the CGE model and the SAM, while section 4 explains the policy scenarios and model closure assumptions and discusses the results of the various policy simulations. Section 5 concludes the paper. A technical appendix that contains various tables and additional information is attached as section 7.

2. Technical change and welfare effects

2.1. Theoretical underpinnings

The notions of productivity and productivity growth are frequently raised in economics. Hall and Taylor (1993:79) define productivity as the amount of output produced per unit of input. They note, however, that it is important to distinguish between labour productivity – the output per unit of labour – and total factor productivity (TFP), which is the output per "*generalised unit of input*". Although the word 'factor' typically refers to primary inputs such as capital and labour, a generalised unit of input also includes materials used as intermediate inputs into the production process. TFP growth, or technical change as it also sometimes referred to, can be defined as the rate of change of the technology used in the production process. Efficiency gains enable producers to produce a unit of output using fewer inputs than before. In a competitive market environment the benefits of efficiency gains are typically realised as reductions in real commodity prices. This may have a demand-side impact (*ceteris paribus*), in which case the gain is also associated with an increase in output.

Consider the following linearly homogenous production function with constant returns to scale, defined in two inputs, capital (K) and labour (L) and a technology parameter (A). Algebraically speaking, technical change can be seen simply as the growth, over time, of the technology parameter.

$$Q = f(A, K, L) \qquad [1]$$

In this formulation of technical change the underlying assumption is that it is Hicks neutral, i.e. the marginal products of capital and labour (MP_K and MP_L) increase by the same proportion (Hall and Taylor, 1993). This can easily be verified using, for example, a Cobb-Douglas production function:

$$\begin{aligned} Q &= A.K^{\alpha}.L^{1-\alpha} \\ MP_K &= \alpha A.K^{\alpha-1}.L^{1-\alpha} \\ MP_L &= (1-\alpha) A.K^{\alpha}.L^{-\alpha} \end{aligned} \qquad [2]$$

In equation set [2] if the technology parameter (A) increases by x% both the marginal productivities of capital and labour will increase by that same percentage. This leaves the marginal rate of technical substitution of labour for capital ($MRTS_{LK}$), defined as the ratio of MP_K to MP_L, unchanged. Such technical change is known as Hicks neutral technical change. Output growth, however, is not only dependent on technical change. The fact that the marginal productivities of capital and labour are positive implies that an increase in the level of capital or labour employed will also cause output to grow. Growth accounting is a method used to estimate, for a given time period, what the impact of technical change has been on growth by separating it from the impact factor growth has on output growth. From the generalised production function in equation [1] we can derive the following total differential, which gives the change in output for a change in labour (*dL*), capital (*dK*) and technology (*dA*) (see Chiang (1984) and Dornbusch *et al*. (1998) for a more detailed explanation).

$$dQ = \frac{\partial f}{\partial K}dK + \frac{\partial f}{\partial L}dL + \frac{\partial f}{\partial A}dA \qquad [3]$$

Dividing through by Q (to give the percentage change in output) and reorganising yields the following:

$$\frac{dA}{A} = \frac{dQ}{Q} - \left(\frac{MP_K.K}{Q}\right)\frac{dK}{K} - \left(\frac{MP_L.L}{Q}\right)\frac{dL}{L} \qquad [4]$$

Since the production function is characterised by constant returns to scale the expressions in brackets sum to one and remain constant (Euler's Theorem). The expressions can therefore be replaced by β and $(1 - \beta)$, denoting the shares of income to factors capital and labour respectively. The above expression can now be described in words as follows:

$$\begin{pmatrix} technical \\ progress \end{pmatrix} = \begin{pmatrix} output \\ growth \end{pmatrix} - \begin{pmatrix} capital \\ share \end{pmatrix} \times \begin{pmatrix} capital \\ growth \end{pmatrix} - \begin{pmatrix} labour \\ share \end{pmatrix} \times \begin{pmatrix} labour \\ growth \end{pmatrix} \qquad [5]$$

which simply states that technical progress is defined as the growth in output unexplained by the growth in inputs.

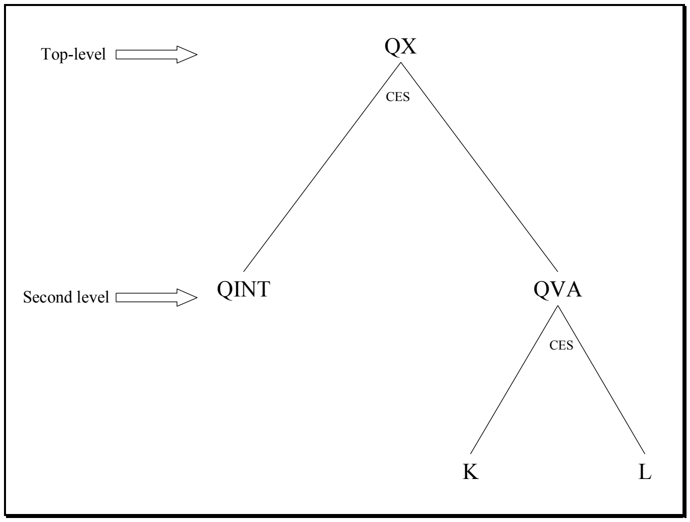
An important aspect of the growth accounting model is that the technical progress term is a "residual" (Domar, 1961). Hence any errors in the measurement of input growth will be reflected in the estimates of technical progress; this property lies behind the argument that if all inputs are measured correctly then technical progress will, by definition, equal zero (Jorgenson and Griliches, 1967). The most emphasised omission is for changes in input quality, especially that of labour. Hartzenberg and Stuart (2002) present an application of the growth accounting model to South Africa that includes the use of a human capital index, based on educational attainment, to 'correctly' account for the growth in labour input over time. Furthermore, the simple (pedagogic) growth accounting model described above excludes growth in the use of natural resources such as land; such omissions can be easily rectified by using a multiple-input production function.

The growth accounting framework described here is usually attributed to Robert Solow. Although it was initially designed for application in aggregate or economy-wide production functions, it is often used at the industry-level to analyse sectoral TFP growth rates. In theory Sectoral TFP measures should be defined as the increase in efficiency that originates within an industry, and hence should exclude the reduction in unit cost attributable to TFP growth that originated in another sector. The effects of TFP growth originating in another sector are realised through reductions in the real cost of intermediate inputs, hence, the inclusion of intermediate inputs as part of the 'generalised unit of input' complicates the measurement process, since efficiency gains in the production of the intermediate inputs should be excluded. It becomes difficult to analyse efficiency gains within one sector while at the same time excluding efficiency effects originating from other sectors, for example, greater efficiency in agricultural production will cause agricultural commodities to become cheaper and hence food industries, which use agricultural commodities as part of their intermediate inputs, will benefit indirectly from the efficiency gain in agriculture. When calculating sectoral rates of technical change the measurement difficulties are substantial if the efficiency originating from within the food industry are to be isolated if agricultural producers have also become more efficient (see Domar (1961) and McDonald (1992) for explanations of how this can be achieved in multi sector whole economy models). Despite these problems it is important to include intermediate input use as part of the 'generalised unit of input' when sectoral rates of technical change are being analysed, since both contribute to changes in the overall efficiency with which a system operates and hence to changes in prices and incomes.

The CGE model used in this study (see section 3) makes use of a two-tier production structure that incorporates both intermediate inputs and primary inputs. This production structure allows for the analysis of various types of technical change that an economy can experience rather than only the simple notion of efficiency gains in the use of primary inputs. Production technologies are defined for each activity (industry) in the economy, each with its own structural features. At the top-level of the production structure (see Figure 1) aggregate primary inputs (referred to here as 'value added', or *QVA*) and aggregate intermediate inputs (*QINT*) are combined to form final output (*QX*). The top-level production function is modelled as a Constant Elasticity of Substitution (CES) function in the CGE model. Essentially, *QVA* and *QINT* can be seen as the production function inputs that are combined to form final output, *QX*. At the second level of the production structure primary inputs, in this case capital (*K*) and labour (*L*)[2], are combined in a CES production function to form *QVA*, while individual intermediate inputs are combined in a Leontief function (not shown in the diagram) to form an aggregated intermediate input, *QINT*.

[2] The model is set-up to allow for capital (or gross operating surplus) and various types of labour, disaggregated by skill and race. The two-input example used here is illustrative and can easily be extended to the multiple-input case.

Figure 1: A two-tier production structure



In equation set [6] below the production structure is shown algebraically, with the 'value added' CES production function (f_{VA}) embedded in the top-level CES production function (f_Q).

$$QX = f_{QX}\left(QINT, QVA, A_{QX}\right) \text{ and } QVA = f_{QVA}\left(K, L, A_{QVA}\right) \qquad [6]$$

In these equations the parameters A_{QX} and A_{QVA} define the current production technologies, and are the standard shift parameters found in CES production functions. Technical change within this production structure can now be defined in one of three ways. First, it can be an improvement in the way in which 'value added' (*QVA*) and intermediate inputs (*QINT*) are combined in the top-level production process. Such technical change can be captured as an increase in A_{QX}. Note that some agricultural activities that use agricultural intermediate inputs produced by other agricultural activities may benefit both as a result of the greater efficiency and due to the lower cost of some intermediate inputs. Thus, although Hicks neutral technical change increases the marginal productivities of intermediate inputs and 'value added' (MP_{QINT} and MPQ_{VA}), one will not necessarily see an equiproportionate reduction in the use of *QVA and QINT* due to this price impact.

Second, technical change can be an improvement in the efficiency at the second level where primary inputs (*K* and *L*) are combined to form 'value added' (*QVA*). This type of efficiency gain is captured as an increase in A_{QVA} and is Hicks neutral only in the sense that we may now equiproportionately reduce the use of *K* and *L* to produce a unit of *QVA*. However, such a change will affect the *MRTS* in the production of *QX* at the top level and, if A_{QX} is remains unchanged, thereby result in a biased form of technical change at the level of the production of *QX*. With such technical change one would expect producers to use more primary factors due to the relative improvement in their productivity, which reduces the relative cost of producing a 'unit' of *QVA* compared to that of intermediate inputs (*QINT*).

A third possibility is a combined effect where efficiency improves at both levels in the production process simultaneously, i.e. not only are primary factors more efficient in their own right, but the process of combining intermediate inputs and 'value added' is also more efficient. The types of technical change described here are therefore Hicks neutral at each level, but not necessarily so overall. This allows for some flexibility in the analysis of different types of technical change within the CGE model, although as the discussion of measurement issues demonstrated there will inevitably be a degree of opacity as to the precise rates of technical change.

Thus far the discussion has focused on productivity changes in the domestic economy. Efficiency changes in competing foreign industries can also have an important effect on the domestic economy, especially in present times of deregulation of international markets and globalisation. Since the South African economy is small and open the country acts as a price taker and any efficiency changes in foreign industries will impact on the domestic economy via changes in world prices of imports and exports. Consequently, in the CGE model, international efficiency gains are captured as reductions in the world prices of imports and exports. The policy scenarios are discussed in more detail in section 4.1.

2.2. The green revolution and technical change in South African agriculture

The term 'green revolution' was coined in the 1960s to denote rapid technological change that resulted from large investments globally in agricultural research and development from the 1940s onwards (Wikipedia, 2004). Although the green revolution was extremely successful at reducing world hunger through reductions in purchaser prices, some concerns have been raised about its wider impact. It has been argued that the green revolution favoured large-scale agriculture while many small-scale farmers did less well, and that biases in technical change and policies may encourage the choice of technologies that were excessively capital intensive (see Griffin, 1979). The issue of who benefits from green revolution technologies has also long been a subject of debate; there is little doubt that consumers gain but the distribution of gains between different types of producer are not always clear (see Scobie and Pasada, 1978). Furthermore, there are concerns about correctly accounting losses in biodiversity and food quality, greater fossil fuel dependence, pollution, and land degradation.

Although the South African agricultural sector has not performed exceptionally well during the last four decades as measured in terms of gross value of output, there is evidence that the volume of output has not declined during the last decade. Consequently the decline in the gross value of agricultural production can be attributed to declining commodity prices

(Vink, 2000). This warrants further investigation into productivity changes of the agricultural sector as a possible source of these price declines. Hartzenberg and Stuart (2002) find that total factor productivity (TFP) growth for the economy as a whole was negative between 1960 and 1975 (-1.0%) and remained unchanged between 1976 and 1989 (0.0%). However, TFP growth recovered during the 1990s (0.8%). A sectoral decomposition reveals that agriculture was one of only a few sectors that experienced positive TFP growth over all the time periods examined by Hartzenberg and Stuart (see Table 1). Vink (2000) and Thirtle *et al*. (2000) also find evidence of a recovery in agricultural TFP growth during the 1990s.

This revival in agricultural productivity growth was stimulated by the 'cost-price squeeze' experienced by agricultural producers: producer prices were increasing over time, but at a lower rate than the increase in input prices (Vink, 2000). Many factors contributed to these price effects. The depreciating domestic currency increased the cost of imported intermediate inputs, while increased labour market regulation increased the non-wage cost of employing workers during the 1990s (Nattrass, 2000). At the same time domestic food and agricultural commodities did not enjoy the same levels of protection as before (Vink, 2000). Producers reacted to the cost-price squeeze by reducing the area of land planted and concentrating production on higher quality land, and by reducing the amount of capital and intermediate goods used in production. This had the effect of increasing productivity and average industry yields (Vink, 2000).

Table 1: TFP growth estimates for South Africa (1960 – 1999) (percentage change)

(Vink, 2000)		(Thirtle *et al.*, 2000)		(Hartzenberg and Stuart, 2002)		
Period	**TFP growth (Agriculture)**	**Period**	**TFP growth (Agriculture)**	**Period**	**TFP growth (Agriculture)**	**TFP growth (Total)**
1960-1980	2.05	1965-1981	2.15	1960-1976	1.00	– 1.00
1980-1990	0.96	1981-1991	2.88	1976-1989	1.70	0.00
1980-1996	1.19					
1990-1996	1.56			1990-1999	N/A	0.80
1960-1996	1.66					

Note: Comparisons should be made with care since time periods, data sources and growth decomposition methods used may differ between researchers. The underlying message that is conveyed here is an apparent recovery in both agricultural and total (economy-wide) TFP growth from the 1990s onwards.

While consumers have benefited from price declines the South African agricultural sector could not avoid the job losses associated with efficiency gains (in addition to job losses caused by capital-labour price distortions during the 1980s, and inflexible labour market policies during the 1990s). Given the complexity of the impact of efficiency gains on the economy the possible scenarios are best analysed within an economy-wide model (such as a CGE model) that takes into account the actions, reactions and interactions of all agents in the economy.

3. Computable general equilibrium model and data

3.1. CGE model

The PROVIDE standard computable general equilibrium (CGE) model is used to model the impact of domestic and international production efficiency changes. This model is a member of the class of single country computable general equilibrium (CGE) models that are descendants of the approach to CGE modelling described by Dervis *et al*. (1982). More specifically, the implementation of this model, using the GAMS (General Algebraic Modelling System) software, is a direct descendant and development of models devised in the late 1980s and early 1990s, particularly those models reported by Robinson *et* al. (1990), Kilkenny (1991) and Devarajan *et al*. (1994). Following Pyatt (1998), the model is based on a Social Accounting Matrix (SAM). The SAM serves to identify the agents in the economy and provides the database with which the model is calibrated. It also serves an important organisational role since the groups of agents identified by the SAM structure are also used to define sub-matrices of the SAM for which behavioural relationships need to be defined.

While the accounts of the SAM determine the agents that can be included within the model, and the transactions recorded in the SAM identify the transactions that took place, the model is defined by the behavioural relationships. The behavioural relationships in this model are a mix of non-linear and linear relationships that govern how the model's agents will respond to exogenously determined changes in the model's parameters and/or variables.

Households are assumed to choose the bundles of commodities they consume so as to maximise utility where the utility function is a Stone-Geary function that allows for subsistence consumption expenditures, which is an arguably realistic assumption when there are substantial numbers of very poor consumers. The households choose their consumption bundles from a set of 'composite' commodities that are aggregates of domestically produced and imported commodities. These 'composite' commodities are formed as CES aggregates based on the so-called Armington assumption that domestically produced and imported commodities are imperfect substitutes (Armington, 1969). In this model the country is assumed to be a price taker for all imported commodities.

Domestic production uses a two-stage production process as described in section 2.1. The production set-up further allows for activities to produce multiple products under the assumption that the proportionate combinations of commodity outputs produced by each activity/industry remain constant; hence for any given vector of commodities demanded there is a unique vector of activity outputs that must be produced. The vector of commodities demanded is determined by the domestic demand for domestically produced commodities and export demand for domestically produced commodities. Using the assumption of imperfect transformation between domestic demand and export demand, in the form of a Constant Elasticity of Transformation (CET) function, the optimal distribution of domestically produced commodities between the domestic and export markets is determined by the relative prices on the alternative markets. The model can be specified as a small country, i.e., price taker, on all export markets, or selected export commodities can be deemed to face downward sloping export demand functions, i.e., a large country assumption. The other behavioural relationships in the model are generally linear.

The model is set up with a range of flexible closure rules. The specific choices about closure rules used in this study are defined in section 4 below. For a detailed description of the price and quantity structures in the model, refer to PROVIDE (2003). The behavioural relationships of the CGE model are presented within a SAM framework as Table 11 in the appendix.

3.2. Data

The data used for this study are arranged in two groups, namely a SAM that records all transactions between agents in the economy, and a series of elasticities that control the operation of the model's behavioural functions.

The SAM is a 118 account aggregation of the PROVIDE SAM for South Africa in 2000 (for a full description of the SAM, see PROVIDE, 2004). The model SAM has 39 commodity groups (of which 11 agricultural and 10 food commodities), 37 activity groups (of which 9 agricultural and 10 food activities), 9 factor groups (8 types of labour, disaggregated across skills and race plus capital[KP1]), 14 household groups (distinguished by residential location, income level and racial group), and miscellaneous enterprise, government, capital (savings and investment) and rest of the world accounts. A full list of the SAM accounts is provided as Table 12 in the appendix.

A feature of the SAM that justifies emphasis here is the treatment of activities and specifically agricultural activities. Usually, by definition, each activity in an input-output structure produces a single commodity and each commodity is produced by a single activity. Since the CGE model is set up to allow for multi-product activities, the SAM uses a supply and use structure that allows for the possibility that activities can produce multiple products. Agricultural activities are defined by reference to regions (provinces) of the country. The regional classification of agricultural activities has a number of implications. Each agricultural activity can produce a range of commodities, and the profitability of farming for all agricultural activities depends upon the effects of policy shock across a range of commodity (output) prices.

4. Policy analysis

4.1. Policy scenarios

The policy scenarios examined in this study are explorations of the impact of domestic and international efficiency gains in agricultural production upon the South African economy. The intention of these explorations is to provide insights into how developments in the South African agricultural sectors might contribute to the wider objectives of the South African government. These explorations are not driven by the immediate and/or imminent pressures of current policy questions but are rather inspired by the general argument that an understanding of how economic systems might react to changes in the economic and technological climate is an important input to the development of economic policies.

The scenarios reported focus on domestic technology changes within the agricultural industries (see section 2.1). A series of simulations are also devoted to international technology changes that impact on the domestic economy via their impact on world prices of agricultural and/or food products. Thus, three sets of simulations are reported:

1. *SIMSET1*: An improvement in the efficiency with which all the agricultural industries use intermediate and primary inputs. This is implemented as an increase in the technology parameter (*adx*) of each industry's top-level CES production function. Five simulations (*sim11* to *sim15*) are implemented that increase the shift parameter by between 0.5% and 2.5% (0.5 percentage point increments).
2. *SIMSET2*: A reduction in the world prices of imported (*pwm*) and exported (*pwe*) food and agricultural commodities due to efficiency gains in international agricultural production. Five simulations (*sim21* to *sim25*) are implemented that directly reduce the world prices of imports and exports by a series of magnitudes. The world prices of agricultural commodities are reduced by between 0.5% and 2.5% (0.5 percentage point increments), while the world prices of food commodities are reduced by between 0.25% and 1.25% (0.25 percentage point increments) (see section 4.3.2 for more detail).
3. *SIMSET3*: This simulation set is a combination of *sim24* and *SIMSET1*. This means that five simulations (*sim31* to *sim35*) are implemented that increase the shift parameter in the top-level CES production function of the agricultural industry by between 0.5% and 2.5% (0.5 percentage point increments), while for each of these simulations the world prices of agricultural commodities are reduced by 2% while the world price of food commodities are reduced by 1%.

In all cases the simulations assume that the origins of these technological changes are exogenous, i.e., the model provides no explanation of how these changes in technology originate nor does the model include allowances for the research and development costs of new technology. Table 2 provides a summary description of all the simulation sets and their member simulations.

Table 2: Description of simulation sets and simulations

Simulation set	**Simulation number and description**				
	sim11	***sim12***	***sim13***	***sim14***	***sim15***
SIMSET1	adx (agric) up (0.50%)	adx (agric) up (0.50%)	adx (agric) up (0.50%)	adx (agric) up (0.50%)	adx (agric) up (0.50%)
	sim21	***sim22***	***sim23***	***sim24***	***sim25***
SIMSET2	pwe & pwm down: agric (0.50%) & food (0.25%)	pwe & pwm down: agric (1.00%) & food (0.50%)	pwe & pwm down: agric (1.50%) & food (0.75%)	pwe & pwm down: agric (2.00%) & food (1.00%)	pwe & pwm down: agric (2.50%) & food (1.25%)
	sim31	***sim32***	***sim33***	***sim34***	***sim35***
SIMSET3	pwe & pwm down: agric (2.00%) & food (1.00%); adx (agric) up (0.50%)	pwe & pwm down: agric (2.00%) & food (1.00%); adx (agric) up (1.00%)	pwe & pwm down: agric (2.00%) & food (1.00%); adx (agric) up (1.50%)	pwe & pwm down: agric (2.00%) & food (1.00%); adx (agric) up (2.00%)	pwe & pwm down: agric (2.00%) & food (1.00%); adx (agric) up (2.50%)

4.2. Model closure rules

The model closure rules were selected with the objective of providing a realistic representation of the South African economy. Mathematically speaking, closure rules ensure that the number of variables and equations in the model are consistent, a necessary condition for the model to solve. In economic terms closure rules define fundamental differences in perceptions of how economic systems operate.

Firstly, the *foreign exchange market* is assumed to clear via a flexible exchange rate and therefore the external balance (or current account balance) remains fixed. Since South Africa is a small country it is a price taker on international markets, i.e. all prices of imported and exported goods are fixed in foreign currency units.

The *capital account***,** which records all savings and investment related transactions, is closed by assuming that the share of investment expenditure in total final domestic demand remains constant. This allows for some variation in the volume of investment due to changes in the prices of investment goods and from any change in the total value of domestic absorption. The equilibriating variables are the savings rates of all households and incorporated business enterprises. These rates are allowed to vary equiproportionately, which ensures that the savings equal investments in the economy.

The *government account* is closed by variations in the level of government borrowing or savings – that is the size of the budget deficit or surplus. All tax rates are assumed to remain constant and the government is assumed to consume a fixed share of total final domestic demand. The impact of the policy shocks evaluated in this paper upon government revenue is small. Consequently the impact of allowing government savings to vary is marginal.

The *factor market* closure involves different treatments for different factors. The labour categories are subdivided into two broad groups – skilled and unskilled (see Table 12). Skilled labour is assumed to be fully employed and mobile across various sectors (activities) in the economy, and hence the equilibriating variable is the wage rate. The supply of unskilled labour is assumed to be perfectly elastic, based on the assumption that there is excess capacity (unemployment) of this type of labour in the economy. Activities can increase employment of unskilled workers by any margin as long as they are willing to pay the constant wage. For physical capital a short run scenario where the quantity of capital used by each activity is fixed is assumed. [KP2]This means that the industry-specific return to capital adjusts to maintain the employment level in the sector.

All prices in a CGE model are expressed relative to the *numéraire*, a fixed price (or price index) in the model. In this study the model numéraire is the consumer price index (CPI), and consequently all the value results of the model are expressed in real terms.

4.3. Results and analyses

4.3.1. Domestic efficiency gains (SIMSET1)

The range of efficiency gains evaluated in *SIMSET1* is consistent with the TFP growth estimates reported in Table 1 and thus represent realistic levels of TFP growth that can be expected to materialise in South African agriculture. Table 3 shows the results of a 2% efficiency gain in all agricultural industries (*sim14*). As a result of the efficiency gains agricultural producers use fewer intermediate inputs (*QINT*), while value added (*QVA*) also declines. The greater efficiency allows producers to produce a unit of output at a lower cost, and hence producer prices (*PX*) decline. These gains are passed on to consumers in the form of lower purchaser prices for agricultural commodities (*PQD*).

The greater efficiency in agriculture has a knock-on effect for food activities. Food industries use agricultural commodities as intermediate inputs in the production of food, and as a result of the decline in *PQD*, food producers can reduce costs through the use of cheaper intermediate inputs as reflected in the decline in *PINT*. Due to the change in relative prices of intermediate inputs and value added producers change their input mix by using more intermediates (*QINT*) and less value added (*QVA*). Food production costs also decline, and these gains are passed on consumers in the form of lower purchaser prices (*PQD*). The decline in food commodity prices is less than the decline in agricultural commodity prices since only about a quarter of food producer costs are accounted for by agricultural intermediates. The remainder is spent on primary factors and other intermediate inputs for which prices have not changed as much.

The decline in agricultural and food commodity prices has a positive welfare effect for consumers. As a result demand for these commodities increase and in response producers increase production, as reflected in the increase in *QX* for most agricultural and food producers. The demand-side effects are discussed in more detail below.

Table 3: Production and commodity price effects (*sim14*, percentage changes)

	Intermediate inputs		**Value added**		**Domestic production**			
[s3]**Activities**	**Quantity (QINT)**	**Price (PINT)**	**Quantity (QVA)**	**Price (PVA)**	**Quantity (QX)**	**Prices (PX)**	**Commodities**	**Purchaser prices (PQD)**
Agricultural activities/commodities								
Western Cape	-0.60	-0.07	-0.33	-0.25	1.52	-2.11	Cereals	-0.96
Northern Cape	-1.49	-0.04	-1.16	-0.27	0.68	-2.13	OtherFieldCrops	-0.80
North West	-1.38	-0.24	-0.36	-0.92	0.96	-2.44	PotatoesandVeg	-3.84
Free State	-1.09	-0.11	-0.38	-0.58	1.16	-2.24	Fruit	-1.59
Eastern Cape	-1.00	-0.12	-0.54	-0.43	1.20	-2.22	OtherHorticulture	-0.31
Kwazulu-Natal	-1.66	-0.21	-0.72	-0.84	0.71	-2.43	LivestockSales	-3.94
Mpumalanga	-1.19	-0.10	-0.28	-0.71	1.13	-2.28	Livestockproducts	-2.54
Limpopo	-2.88	-0.18	-0.60	-1.71	-0.07	-2.70	OtherAnimals	-4.68
Gauteng	-2.30	-0.35	-0.55	-1.52	0.32	-2.73	Otheragriculture	-1.89
Food activities/commodities								
Meat	1.07	-1.58	-0.85	-0.32	0.96	-1.51	Meatproducts	-1.50
Fruit	0.31	-0.08	-0.00	0.13	0.24	-0.03	Fruitandvegetablesproducts	-0.05
Oils	0.51	-0.25	-0.04	0.11	0.42	-0.20	Oilsandfatsproducts	-0.11
Dairy	0.47	-0.49	-0.33	0.04	0.36	-0.41	Dairyproducts	-0.39
Grainmills	0.47	-0.41	-0.18	0.02	0.37	-0.35	Grainmillproducts	-0.32
Animal feeds	-1.27	-0.81	-1.49	-0.67	-1.30	-0.79	Animalfeeds	-0.75
Bakeries	0.15	-0.07	-0.04	0.06	0.10	-0.04	Bakeryproducts	-0.07
Confectionery	0.43	-0.22	-0.00	0.07	0.34	-0.15	Confectioneryproducts	-0.16
Otherfood	1.14	-0.91	-0.17	-0.05	0.78	-0.67	Otherfoodproducts	-0.61
Beverages & tobacco	0.40	-0.19	-0.07	0.12	0.28	-0.11	Beveragesandtobaccoproducts	-0.10

Table 4 shows the commodity flow (demand- and supply-side) effects for food and agricultural commodities. An important result of domestic efficiency gains is domestic producers' greater competitiveness in international markets, as reflected in the strong export drive for agricultural producers, and to a lesser extent, food producers. Lower agricultural and food commodity prices domestically also lead to an increase in demand for domestically produced goods from within the economy (*QD*). As a result the quantities of domestically produced commodities increase (*QXC*). Since domestically produced goods are now also relatively cheaper than imports, consumers substitute domestically produced goods for imported agricultural and food commodities (*QM*) . There is also an income effect as reflected in the overall increase in the composite commodity (*QQ*). Note that the commodity flows in Table 4 reflect changes in quantities and not changes in values.

Table 4: Commodity flows (*sim14*, percentage changes)

	Domestic production (QXC)	**Composite commodity (QQ)**	**Domestic demand (QD)**	**Exports (QE)**	**Imports (QM)**
Agricultural commodities	0.94	0.45	0.66	3.04	-1.96
Food commodities	0.42	0.26	0.36	1.37	-0.67

Note: The commodity accounts in the SAM are disaggregated into various agricultural and food commodities. The percentage changes reported here are the percentage changes in the total quantities of agricultural and food commodities and thus represent a 'weighted' average percentage change.

Efficiency gains also have a direct impact on factor demand (see Table 5). Since the marginal productivity of factors increase, fewer workers are needed to produce a unit of output. All agricultural producers reduce the demand for skilled and unskilled workers, thus leading to a fall in agricultural employment. There is also a decrease in demand for labour in food-producing industries, but as explained previously, this is an indirect effect arising as a result of the changing relative prices of intermediate inputs and value added.

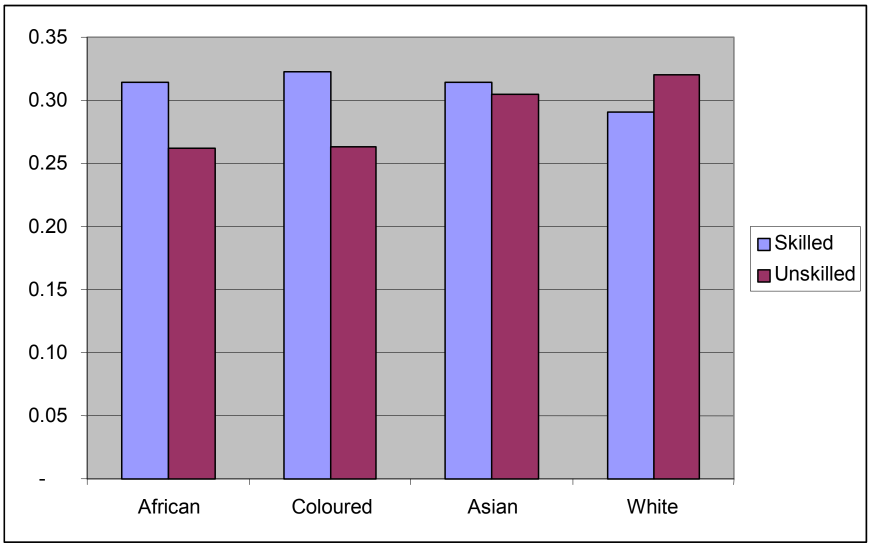
Given the assumption that skilled workers are fully employed and mobile between sectors, skilled factors that are released from the agricultural and food industries are absorbed elsewhere in the economy so that the overall level of employment remains unchanged. However, as a result of higher productivity of skilled workers their wages increase. The net effect is higher factor income (*YF*) for all skilled workers (see Figure 2). Demand for unskilled labour also increases in non-agricultural sectors due to increased overall economic activity (see Table 5). The net effect is an increase in the level of unskilled employment at the economy-wide level despite the decrease in the agricultural and food sectors. This causes the factor incomes of unskilled workers to also increase at the economy-wide level, although generally the increase is not as high as for skilled workers (see Figure 2).

These results highlight an important aspect of efficiency gains. Although employment levels in the industry that experiences such gains may decrease, it is imperative to look at the economy-wide effects. In the South African example agricultural efficiency gains have a net positive employment impact, which demonstrates that declining employment levels in agriculture should not be viewed in isolation. However, it is important to recognise two things; first, the employment gains are only realised when all the general equilibrium effects have worked through the system, and second that the results refer to groups of workers not individuals. Hence the results for skilled workers depend upon the assumption that they are mobile across activities, while those for unskilled workers do not mean that that those individuals released by the agricultural sector necessarily fill the additional unskilled jobs that have been created in non-agricultural sector. It may therefore be that rural unemployment, associated with employment in the agricultural industry, increases, while urban unemployment, associated with other industries, decreases with an overall net positive effect on employment of unskilled workers.

Table 5: Factor demand (*FD*) effects (*sim14*, percentage changes)

Factor groups	**African skilled**	**African unskilled**	**Coloured skilled**	**Coloured unskilled**	**Asian skilled**	**Asian unskilled**	**White skilled**	**White unskilled**
FD (agric)	-2.32	-1.82	-1.34	-0.84	-2.44	-1.97	-1.73	-1.41
FD (food)	-0.71	-0.18	-0.81	-0.20	-0.61	-0.35	-0.62	-0.35
FD (other)	0.01	0.36	0.02	0.39	0.01	0.37	0.06	0.34

Figure 2: Economy-wide factor income effects (*YF*) (*sim14*, percentage changes)



[s4]

In conclusion, although efficiency gains in the agricultural industry have a negative employment impact in the agricultural and food industries, gains experienced elsewhere allow overall employment levels (unskilled workers) and wages (skilled workers) to increase. This leads to an increase in household incomes. At the same time consumers are also better off due to lower purchaser prices, thus leading to welfare increases for households from both price reduction and income effects.

4.3.2. International technical change (SIMSET2)

International efficiency gains are captured as a reduction in the world prices of imports and exports. *SIMSET1* has shown that efficiency gains in the agricultural sector impact directly on domestic agricultural prices, and indirectly on food commodity prices, although to a lesser extent. As a price-taker the South African economy will therefore face lower world prices of imports and exports of agricultural and food commodities. Since the price impact of agricultural efficiency gains is likely to be slightly less for food commodities, *SIMSET2* reduces international food commodity prices by half that of agricultural commodity prices.

The commodity flow effects of *sim24* are shown in Table 6. A reduction in the world price of exports (*pwe*), *ceteris paribus*, will cause domestic producers to shift output towards the domestic market (*QD*) and away from the export market (*QE* declines). This causes the trade balance to deteriorate, leading to an exchange rate depreciation. If at the same time there is also a reduction in the world price of imports (*pwm*), domestic demand for imports (*QM*) will rise, thus putting further pressure on the exchange rate to depreciate. Despite the compounding effect of these two scenarios the overall impact of the world trade price declines is minimal, mainly because the actual magnitude of the international price changes are fairly small (the exchange rate depreciates by between 0.02% and 0.10% in simulations *sim21* to *sim25*). As before the impact on domestic consumption (*QQ*) is small due to the small income effect. The international and domestic demand movements put pressure on demand for domestically produced commodities, as reflected in the decline in production of both food and agricultural commodities (*QXC*).

Table 6: Commodity flows (*sim24*, percentage changes)

	Domestic production (QXC)	**Composite commodity (QQ)**	**Domestic demand (QD)**	**Exports (QE)**	**Imports (QM)**
Agricultural commodities	-0.46	-0.14	-0.28	-1.85	1.49
Food commodities	-0.18	0.00	-0.11	-1.46	1.02

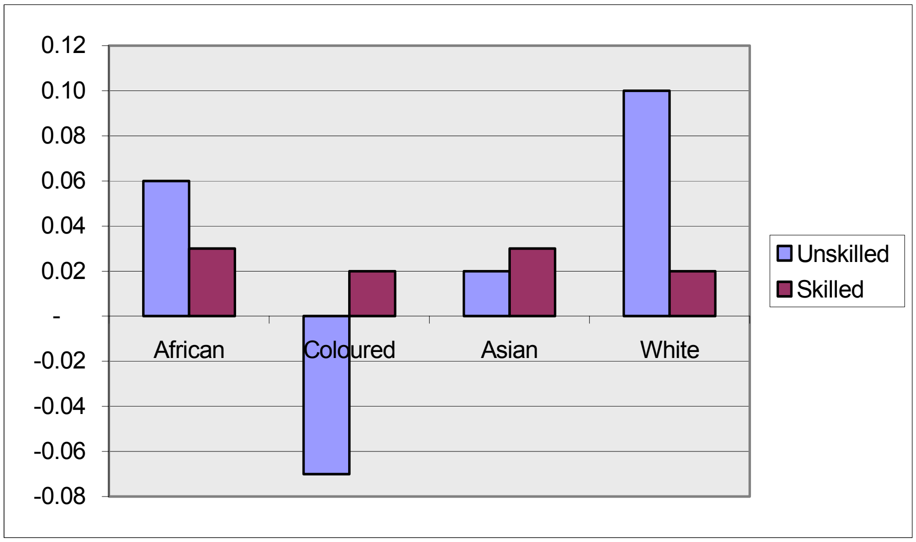
Although production levels decline, the impact is not all negative for domestic producers. Producers benefit from the lower import prices since a component of intermediate inputs is imported. This is reflected in the prices of intermediate inputs that decline for agricultural and food activities (not shown here). The decline in production impacts negatively on employment in the agricultural and food industries, with factor demand (*FD*) declining marginally (see Table 7). Factor demand in other industries either remains unchanged or increases marginally as a result of the positive welfare effects associated with cheaper imported commodities.

Figure 3 summarises the impact on factor income (*YF*) for skilled and unskilled workers. All skilled workers experience wage increases due to an economy-wide increase in demand for skilled labour. Employment of all unskilled workers (with the exception of Coloured unskilled workers) also increases at the economy-wide level. Hence, virtually all factors experience an increase in factor income, although changes are very small. Many Coloured unskilled workers are employed as agricultural workers in the Western Cape region. This region experiences the largest decline in production of all the agricultural industries due to their heavy reliance on exports, which explains why the net income effect is negative for this group.

Table 7: Factor demand (*FD*) effects (*sim24*, percentage changes)

Factor groups	African skilled	African unskilled	Coloured skilled	Coloured unskilled	Asian skilled	Asian unskilled	White skilled	White unskilled
FD (agric)	-0.52	-0.55	-1.32	-1.28	-0.65	-0.61	-1.00	-0.86
FD (food)	-0.49	-0.42	-0.40	-0.39	-0.50	-0.42	-0.56	-0.65
FD (other)	0.00	0.10	0.01	0.06	0.01	0.06	0.04	0.11

Figure 3: Economy-wide factor income effects (*YF*) (*sim24*, percentage changes)



In conclusion, a reduction in world prices of both imports and exports has a very limited effect on the domestic economy. Production levels in the food and agricultural sectors decline, leading to a fall in the demand for factors in these industries. However, most of these losses are made up by increases in production and factor demand in other industries. As a result the welfare effects of the simulations are very small, with the only real benefit going to consumers who can import goods at a lower price.

4.3.3. Combined domestic and international efficiency gains (SIMSET3)

In *SIMSET3* the outcome of simultaneous domestic and international technical changes are evaluated. As with *SIMSET2* the decline in world trade prices causes the exchange rate to depreciate. These trade price changes induce consumers to substitute domestically produced goods for cheaper imported goods, while domestic producers tend to allocate more of their production to the domestic market where prices are now relatively higher. However, there is also a domestic price impact associated with the efficiency gains in the agricultural sector. As shown in *SIMSET1* producer prices (*PX*) of agricultural activities fall as a result of the efficiency gains. This has a direct impact on agricultural commodity prices, while food commodity prices also decline as an indirect result (*PQD*).

These domestic price movements have two important impacts. First, it counteracts the movement along the CES aggregation function caused by cheaper imports; and, second, it counteracts the movement along the CET allocation function caused by cheaper exports. The impact on the trade balance is thus greatly reduced (see Table 8, compare Table 4 and Table 6). Also note that the change in the quantity of domestically produced commodities (*QXC*) is lower than under the domestic efficiency gain simulation due to the negative impact of the international price declines.

Table 8: Commodity flows (*sim34*, percentage changes)

	Domestic production (QXC)	**Composite commodity (QQ)**	**Domestic demand (QD)**	**Exports (QE)**	**Imports (QM)**
Agricultural commodities	0.46	0.30	0.37	1.13	-0.50
Food commodities	0.23	0.26	0.25	-0.13	0.34

While Table 8 only reports on the results of a 2% increase in efficiency, it is important to look at the entire range of productivity changes to understand that the level of the efficiency gain will determine whether the overall agricultural production effect is positive. The results in Table 9 indicate that only at a 2% efficiency gain will all domestic agricultural producers experience production growth that is sufficient to counteract the 2% decline in the world prices of exports (*sim34*). At the economy-wide level the agricultural sector 'breaks even' if domestic efficiency gains equal 1% (*sim32*). Table 9 also clearly shows that different regions are affected in different ways by these simulations.

Table 9: Domestic agricultural production (*QX*) (*sim31*-*sim35*, percentage changes)

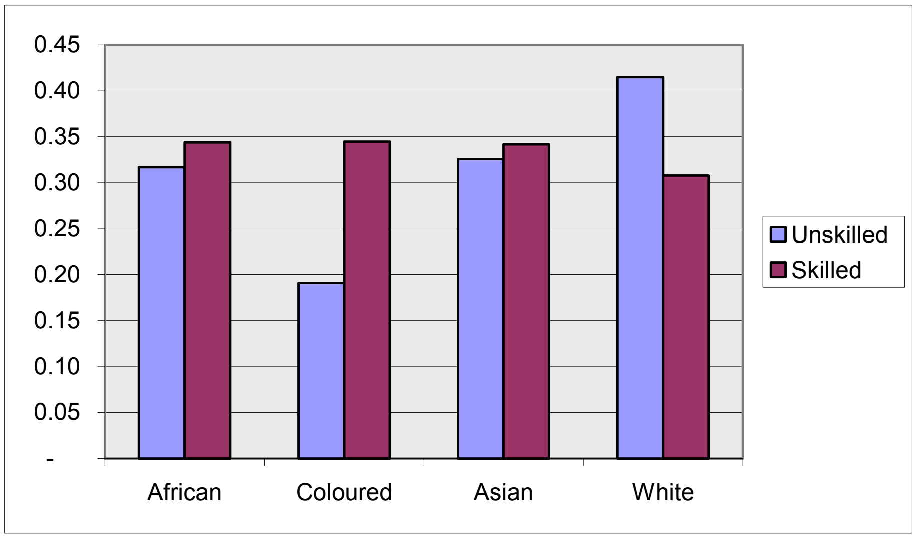
	sim31 (0.5%)	*sim32 (1.0%)*	*sim33 (1.5%)*	*sim34 (2.0%)*	*sim35 (2.5%)*
Western Cape Agriculture	-0.59	-0.22	0.15	0.52	0.89
Northern Cape Agriculture	-0.49	-0.33	-0.16	0.00	0.17
North West Agriculture	-0.34	-0.11	0.13	0.37	0.60
Free State Agriculture	-0.35	-0.07	0.22	0.50	0.79
Eastern Cape Agriculture	-0.16	0.14	0.43	0.72	1.01
Kwazulu-Natal Agriculture	-0.17	0.00	0.18	0.35	0.53
Mpumalanga Agriculture	-0.12	0.16	0.44	0.72	0.99
Limpopo Agriculture	0.31	0.30	0.28	0.26	0.24
Gauteng Agriculture	0.30	0.38	0.45	0.54	0.62
All Agriculture	*-0.23*	*0.00*	*0.23*	*0.46*	*0.69*

Due to increased productivity, factor demand (*FD*) declines in all agricultural and food industries (see Table 10), but despite this the economy-wide level of employment of unskilled workers increases as a result of greater demand for factors in other expanding non-agricultural sectors. The increased factor demand in other industries is reflected in higher wages for skilled workers and higher employment levels for unskilled workers, thus leading to an overall increase in factor income (*YF*) for all workers (see Figure 4).

Table 10: Factor demand (*FD*) effects (*sim34*, percentage changes)

Factor groups	African skilled	African unskilled	Coloured skilled	Coloured unskilled	Asian skilled	Asian unskilled	White skilled	White unskilled
FD (agric)	-2.84	-2.38	-2.67	-2.14	-3.08	-2.58	-2.73	-2.28
FD (food)	-1.28	-0.65	-1.31	-0.64	-1.19	-0.78	-1.48	-1.01
FD (other)	0.02	0.46	0.02	0.44	0.02	0.39	0.09	0.45

Figure 4: Economy-wide factor income effects (YF) (*sim34*, percentage changes)

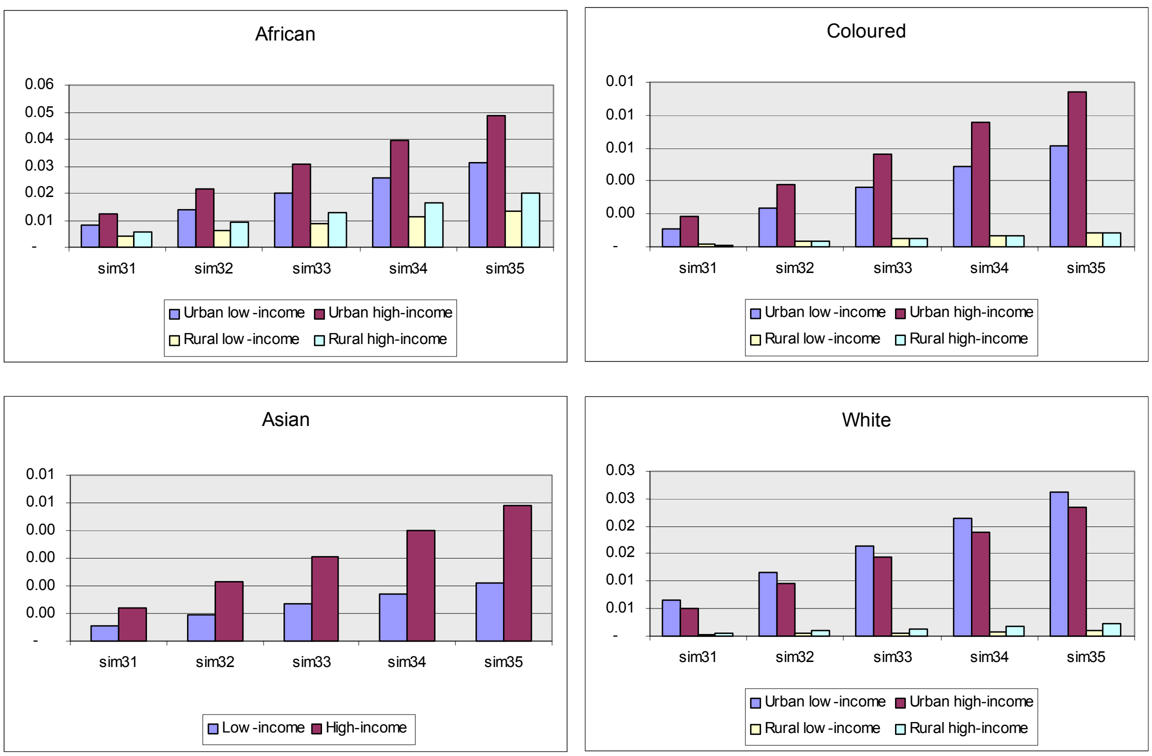


While the consumer welfare effects in terms of price changes and income changes are very small in all the simulation sets, it is interesting to compare the relative welfare effects between different household groups in the model. One of the results parameters generated by the CGE model is welfare measure based on the equivalent variation (*EV*) (for more on the definition and interpretation of EV see Gravelle and Rees, 1992:117-119). Figure 5 shows the percentage changes in consumer welfare for each household group. The separate graphs for each racial group compare the welfare change between low and high-income urban and rural households.

The positive relationship between greater levels of technical change (*sim31* to *sim35*) and welfare is significant. Also apparent is the relative disadvantage of rural households across all racial groups. This is due to the adverse effects of fewer agricultural employment opportunities (mainly in rural areas) associated with domestic and international efficiency gains, which affects income levels and hence consumer welfare. Urban households, on the other hand, benefit from the combined effect of lower consumer prices and increased employment opportunities in non-agricultural sectors.

Also important is the relative disadvantage of low-income households compared to high-income households, even within rural and urban areas. One possible explanation is the strong link between skilled workers and high-income households, and unskilled workers and low-income households. The returns to skilled workers are slightly higher on average (Figure 4), which causes household income of low-income households to increase, on average, by less than that of high-income households. Thus, although all households are better off under all the scenarios reported the results are slightly biased against low-income rural households, which may have important policy implications given the already skewed distribution of income in South Africa.

Figure 5: Welfare effects by household groups (*sim31*-*sim35*, percentage changes)



5. Conclusions

Domestic and international efficiency gains have small but important welfare effects in the South African economy. Under all the scenarios reported here, whether international trade prices of food and agricultural commodities decline, or whether domestic agricultural producers experience efficiency gains, consumers benefit from lower prices of especially agricultural goods, and, to a lesser extent, food products. For the economy as a whole, households generally see their incomes increase, which means that the welfare effects associated with lower prices and higher incomes are unambiguously positive.

Producers, and in particular agricultural producers, face production declines when foreign agricultural producers experience efficiency gains. It is therefore important for domestic producers to counteract this by also increasing productivity and hence the competitiveness of the industry. This will allow greater penetration of export markets, while price reductions further leads to increases in domestic demand. The results also show that domestic and international agricultural efficiency gains cause the agricultural industry to shed labour. The important lesson is that calls for greater efficiency in agriculture necessarily imply that employment in agriculture is likely to decline. However, the overall employment or wage effect is positive due to increases in demand for factors in other industries that benefit indirectly from the efficiency gains in agriculture.

Although the job losses are made up for in other industries it is important that government consider relief policies for the interim adjustment period. This may include retraining workers for work in other industries or creating job opportunities in rural areas where most of the job losses are likely to occur. There are also some concerns about the distributional effect of agricultural efficiency gains. Although all households experience welfare gains, urban households and high-income households gain relatively more than their rural and low-income counterparts. Policies may have to be put in place to prevent inequality to increase further.

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7. Appendix

Table 11: Behavioural relationships for the standard CGE model presented within a SAM framework

	Commodities	Activities	Factors	Households	Enterprises	Government	Capital	RoW	Total	Prices
Commodities	0	Leontief Input-Output Coefficients	0	Utility Functions (Stone-Geary or CD)	Fixed in Real Terms	Fixed in Real Terms and Export Taxes	Fixed Shares of Savings	Commodity Exports (CET)	Commodity Demand	Consumer Commodity Price Prices for Exports
Activities	Domestic Production	0	0	0	0	0	0	0	Constant Elasticity of Substitution Production Functions	
Factors	0	Factor Demands (CES or CD)	0	0	0	0	0	Factor Income from RoW	Factor Income	
Households	0	0	Fixed Shares of Factor Income	Fixed (Real) Transfers	Fixed (Real) Transfers	Fixed (Real) Transfers	0	Remittances	Household Income	
Enterprises	0	0	Fixed Shares of Factor Income	0	0	Fixed (Real) Transfers	0	Transfers	Enterprise Income	
Government	Tariff Revenue	Indirect Taxes on Activities	Fixed Shares of Factor Income	Direct Taxes on Household Income	Direct Taxes on Enterprise Income	0	0	Transfers	Government Income	
Capital	0	0	Depreciation	Household Savings	Enterprise Savings	Government Savings (Residual)	0	Current Account 'Deficit'	Total Savings	
Rest of World	Commodity Imports	0	Fixed Shares of Factor Income	0	0	0	0	0	Total 'Expenditure' Abroad	
Total	Commodity Supply (Armington)	Activity Input	Factor Expenditure	Household Expenditure	Enterprise Expenditure	Government Expenditure	Total Investment	Total 'Income' from Abroad		
	Producer Commodity Prices Domestic and World Prices for Imports	Value Added Prices								

Table 12: SAM Accounts for this study

SAM Name	Description	SAM Name	Description	SAM Name	Description	SAM Name	Description
CCEREAL	Cereals	CELMACH	Electrical machines	AFOOD	Otherfood	HAFRL	African rural low
COFIELD	Other Field Crops	CVEHIC	Vehicles	ABEVT	Beverages & tobacco	HAFRH	African rural high
CPOTVEG	Potatoes and Veg	CMISC	Miscellaneous manufactures	ATEXTIL	Textile products	HCOUL	Coloured urban low
CFRUIT	Fruit	CUTIL	Utilities	ALEATS	Leather products	HCOUH	Coloured urban high
COHORT	Other Horticulture	CCONSTR	Construction	AWPAP	Wood and Paper	HCORL	Coloured rural low
CLSTOC	Livestock Sales	CMARGIN	Trade and transport	ACHEM	Chemical Products	HCORH	Coloured rural high
CLPROD	Livestock products	CTSERV	Business services	ARUBPL	Rubber and Plastic	HASRL	Asian low
COANIM	Other Animals	CGOVT	Government services	ANONMET	Non metal products	HASRH	Asian high
CAGOTHER	Other agriculture	CDSERV	Domestic Services	AMETAL	Metal products	HWHUL	White urban low
CGOLD	Gold and uranium ore products	MTRADE	Trade margin	AMACH	Machinery	HWHUH	White urban high
CCROIL	Crude oil	MTRANS	Transport margin	AELMACH	Electrical machines	HWHRL	White rural low
COMINE	Other mining products	AGWC	Western Cape Agriculture	AVEHIC	Vehicles	HWHRH	White rural high
CMEAT	Meat products	AGNC	Northern Cape Agriculture	AMISC	Miscellaneous manufactures	IMPTAX	Import duties
CVEG	Fruit and vegetables products	AGNW	North West Agriculture	AUTIL	Utilities	EXPTAX	Export taxes
COILS	Oils and fats products	AGFS	Free State Agriculture	ACONSTR	Construction	VATM	Value added tax on imports
CDAIRY	Dairy products	AGEC	Eastern Cape Agriculture	AMARGIN	Trade and transport and communication	VATD	Value added tax on domestic go
CGRAIN	Grain mill products	AGKZ	Kwazulu-Natal Agriculture	ATSERV	Business services	ECTAX	Excise duty
CAFEED	Animal feeds	AGMP	Mpumalanga Agriculture	AGOVT	Government services	SALTAX	Sales taxes
CBAKE	Bakery products	AGLP	Limpopo Agriculture	ADSERV	Domestic Services	SALSUB	Sales subsidies
CCONFEC	Confectionery products	AGGT	Gauteng Agriculture	FGOS	Gross operating surplus	INDTAX	Production taxes
CFOOD	Other food products	AGOLD	Gold and uranium ore	FAFSKIL	African skilled labour	INDSUB	Production subsidies
CBEVT	Beverages and tobacco products	AOMINES	Other mining	FAFUSKIL	African unskilled labour	INDREF	Production refunds or VAT
CTEXTIL	Textile products	AMEAT	Meat	FCOSKIL	Coloured skilled labour	FACTTAX	Factor taxes
CLEATS	Leather products	AFRUIT	Fruit	FCOUSKIL	Coloured unskilled labour	DIRTAX	Direct income taxes
CWPAP	Wood and Paper	AOILS	Oils	FASSKIL	Asian skilled labour	GOVT	Government
CCHEM	Chemical Products	ADAIRY	Dairy	FASUSKIL	Asian unskilled labour	ENT	Business Enterprises
CRUBPL	Rubber and Plastic	AGRAIN	Grainmills	FWHSKIL	White skilled labour	KAP	Savings
CNONMET	Non metal products	AAFEED	Animal feeds	FWHUSKIL	White unskilled labour	DSTOC	Stock Changes
CMETAL	Metal products	ABAKE	Bakeries	HAFUL	African urban low	ROW	Rest of the World
CMACH	Machinery	ACONFEC	Confectionery	HAFUH	African urban high	TOTAL	Account totals

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