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Abstract

This paper reports the results of a computable general equilibrium (CGE) analysis of the South African sugar industry. The study was inspired by analyses of the EU South Africa Free Trade Agreement that indicated the importance of sugar exports to the welfare gains from agricultural trade liberalisation and by the increasing pressure upon OECD countries to reform their sugar (trade) policies. In addition to the effects of trade liberalisation this study also considers the implications of increases in the efficiency with which sugarcane is converted to raw sugar, which is an important determinant of the competitiveness of sugar production and exports. The results indicate that there would be substantial welfare gains across all household groups and that overall agricultural producers in South Africa should benefit; however there are substantial variations in the impact upon agricultural producers in different provinces, with farmers in some provinces facing reductions in the profitability of farming.

Keywords: Sugar; South Africa; Computable General Equilibrium; Trade.

JEL classification: N57; D58; Q17.

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1. Introduction

Sugar is a basic foodstuff that is consumed in all countries. Although it cannot be considered a dietary staple, as can rice and maize, raw sugar is nonetheless regarded as an essential food commodity by many governments. The sugar industry has a number of key characteristics that differ markedly to those of other agricultural commodities. These relate to its trade structures, production characteristics, and associated political economy issues. It is because of these characteristics that the sugar industry provides an interesting case study that warrants special attention. First, there are severe distortions in world sugar markets as a result of government policy interventions and preferential trade agreements. Second, the physical characteristics of sugar production have joint production characteristics, meaning that the growth, storage and processing of sugarcane are interdependent activities. This is unlike most agricultural crops, for which the production, storage and processing are independent activities, with markets existing for both the processed and unprocessed product. And third, sugar is a political commodity, around which numerous political economy issues abound, both between and within countries.

South Africa produces an average of 2.5 million tons of raw sugar per season, of which approximately 50 percent is exported to markets in Africa, Asia, the Middle East, North America and Europe. The remainder is marketed in the South African Customs Union (SACU). Thus, the South African sugar industry plays an important role at the international, national and regional levels. Furthermore there is evidence (McDonald and Walmsley, 2004) that suggests that the export performance of the South African sugar industry may be an important determinant of any welfare gains for South Africa achieved through the blateral and/or multilateral liberalisation of food and agricultural trade.

If the on-going attempts to liberalise world agricultural trade via the World Trade Organisation, witness the discussions at Doha and Cancun, prove successful then sugar is one of those commodities that is likely to experience substantial changes in prices and trade flows, although it is also one of the most contentious commodities (van den Mensbrugghe *et al*., 2003; Beghin and Aksoy 2003). Given the scale of sugar production in South Africa it would be expect that substantial changes in the global sugar market are likely to have non trivial implications for the South African economy. The analyses reported in this paper are conducted under the assumption that there is some liberalisation of world sugar trade, which in line with other studies is presumed to cause the world (traded) price of sugar to rise and with the price rise that South Africa's export opportunities will increase. The response of the sugar industry is complicated by complex interactions between the sugar cane growers and the cane processing factories. A crucial dimension of the efficiency of sugar production is the tonnes of cane required to produce a tonne of raw sugar (TCTS ratio); hence the analyses in this paper also consider the impact of improvements in the TCTS ratio; these can be conceived of as arising as a consequence of the pro-competitive impact of trade liberalisation.

The rest of this paper is organised as follows. The next section considers the South African sugar industry. In section 3 the computable general equilibrium (CGE) model and the data used for these analyses are outlined. The core of the paper is section 4: this starts with a description of the policy scenarios that are simulated, this is followed by descriptions of the model's closure rules that are used for the simulations and then the results of the simulations are discussed. The discussion of the results focuses on both the internal effects and the trade effects. The final section provides some concluding comments and suggestions for future explorations. Some additional information is reported in the Appendix.

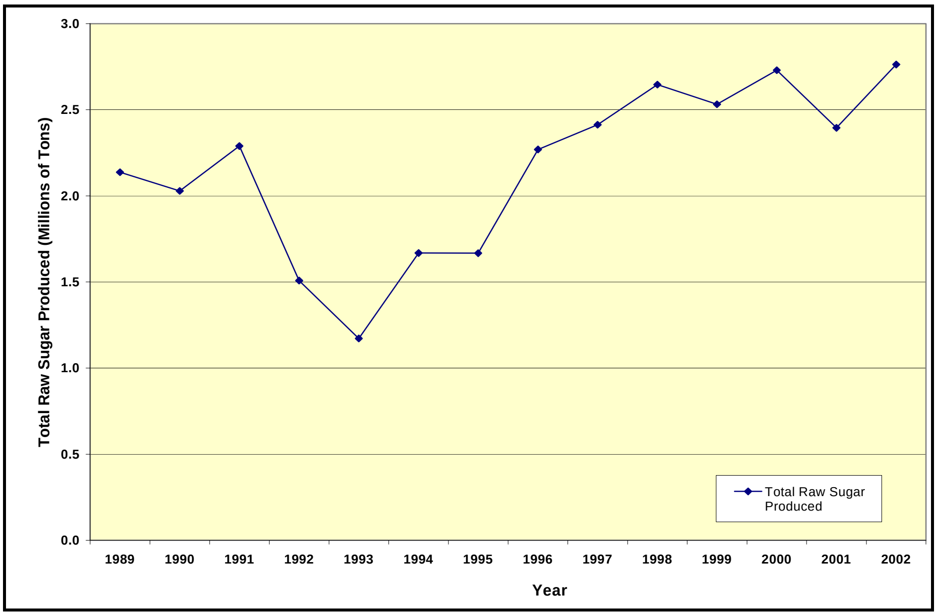
2. The South African Sugar Industry

The sugar industry is a key agricultural sector within the South African economy, both in terms of production and employment. South Africa was the seventh largest exporter of raw sugar in 2002/2003, with sugar making a significant contribution to the country's foreign exchange earnings. The industry is responsible for providing direct employment in cane production and cane processing, whilst simultaneously creating indirect employment in various support industries such as the chemicals and fertilisers, transport and food sectors.

Sugar cane is grown in an area that extends from the Northern Pondoland in the Eastern Cape through KwaZulu-Natal to the Mpumalanga Lowveld. There are a total of 15 sugar mills, of which 13 are located in KwaZulu-Natal and the remainder in Mpumalanga province. Since 1996, an average of 22 million tons of sugarcane has been delivered to the mills each season, from which 2.5 million tons of raw sugar are extracted. Figure 1 shows South Africa's raw sugar production since 1989. The decline in raw sugar production between 1992 and 1996 was a result of the severe four-year drought that affected South Africa during this period.

There are approximately 50,000 registered sugar cane growers, of whom 48,000 are classified as small-scale growers (SSG's). SSG's are defined by Bates and Sokhela (2003, p105) as growers who produce less than 2,100 tons of sugar cane per season, whilst the South African Canegrowers Association describes them as those growers who currently deliver on average not more than 225 tonnes of Recoverable Value (RV) per year. The reason for this cut-off is that this tonnage would require a maximum of about 40 hectares (Bates and Sokhela, 2003, p105). In the 2001–2002 season, SSG's "produced 14.4% of the sugar cane crop on 19.7% (85,418 hectares) of sugarcane land" (Bates and Sokhela, 2003, p105). The majority of SSGs produce sugarcane in the communal areas surrounding the Amatikulu, Felixton, Entumeni, and Umfolozi mills in KwaZulu-Natal. In contrast, there are approximately 2,000 large-scale growers who account for 75 percent of total sugar cane production. Milling companies who own their own sugar estates produce the remaining 11 percent of the crop. However, according to SASA (2003), this percentage has decreased over the past few years as the milling companies have attempted to promote economic development amongst previously disadvantaged people by making farms available to medium-scale farmers at market-related prices. There are likely to be increasing pressures to increase the number of SSG in response to the acceleration of the land reform/redistribution programme in South Africa following the 2004 elections.

Figure 1 South Africa's Total Raw Sugar Production from 1989 to 2002



Source: South African Sugar Association, 2003.

The production of raw sugar requires the close coordination of cane growing and cutting with milling. Ideally sugarcane would be cut at the time in its growing cycle where the recoverable sugar content was at its greatest, but milling is a highly capital intensive activity and consequently profitable operation of sugar mills requires running the mills over an extended season, hence cane is cut over a long period of time (up to 9 months) despite the fact that the sugar yield varies over that period. In addition the profitability of milling is heavily influenced by the time lapse between cutting and processing the cane; the yield of raw sugar from a given quantity of sugarcane declines the longer the period between cutting and processing, with the rate of decline increasing rapidly. A key indicator of the efficiency of (integrated) sugar production is therefore the quantity of cane required to produce a tonne of raw sugar, the so-called Tonnes Cane to Tonnes Sugar (TCTS) ratio. Since 1989 the TCTS ratio for South Africa has been between 8.5 and 10 (SASA, 2003).

3. Computable General Equilibrium Model and Data

3.1. Computable General Equilibrium Model

The PROVIDE standard computable general equilibrium (CGE) model[2] is a member of the class of single country computable general equilibrium (CGE) models that are descendants of the approach to CGE modeling described by Dervis *et al*., (1982). More specifically, the implementation of this model, using the GAMS (General Algebraic Modeling 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). The model is a SAM based CGE model, wherein the SAM serves to identify the agents in the economy and provides the database with which the model is calibrated. The SAM 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. As such the modelling approach has been influenced by Pyatt's 'SAM Approach to Modeling' (Pyatt, 1988).

The description of the model here is necessarily brief and proceeds in two stages. The first stage is the identification of the behavioural relationships; these are defined by reference to the sub matrices of the SAM within which the associated transactions are recorded. The second stage uses a pair of figures to explain the nature of the price and quantity systems for commodity and activity accounts that are embodied within the model.

3.1.1. Behavioural Relationships

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. Table 1 summarises the model relationships by reference to the sub matrices of the SAM.

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

[2] The PROVIDE standard computable general equilibrium (CGE) model used for this study is fully documented in PROVIDE (2003); the description given below is a brief overview of the model's structure and principles.

and imported commodities. These ‘composite’ commodities are formed as Constant Elasticity of Substitution (CES) aggregates that embody the presumption that domestically produced and imported commodities are imperfect substitutes. The optimal ratios of imported and domestic commodities are determined by the relative prices of the imported and domestic commodities. This is the so-called Armington assumption (Armington, 1969), which allows for product differentiation via the assumption of imperfect substitution (see Devarajan *et al*., 1994). The assumption has the advantage of rendering the model practical by avoiding the extreme specialisation and price fluctuations associated with other trade assumptions. In this model the country is assumed to be a price taker for all imported commodities.

Domestic production uses a two-stage production process. In the first stage aggregate intermediate and aggregate primary inputs are combined using CES technology. Hence aggregate intermediate and primary input demands vary with the relative prices of aggregate intermediate and primary inputs. At the second stage intermediate inputs are used in fixed proportions relative to the aggregate intermediate input used by each activity. The ‘residual’ prices per unit of output after paying for intermediate inputs, the so-called value added prices, are the amounts available for the payment of primary inputs. Primary inputs are combined to form aggregate value added using CES technologies, with the optimal ratios of primary inputs being determined by relative factor prices. The activities are defined as multi-product activities with 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 the Policy Analysis section below.

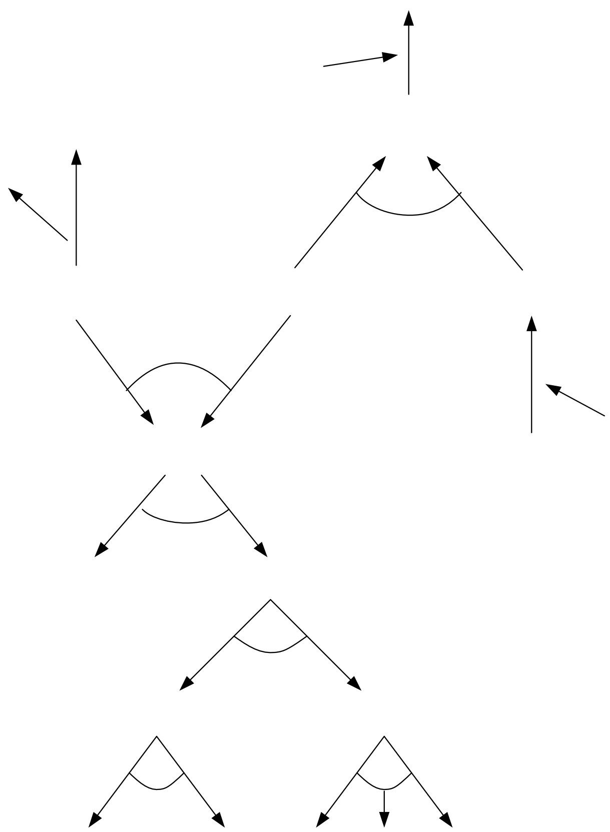
Table 1 Relationships for the Standard Model

	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								

3.1.2. Price and Quantity Relationships

Figures 2 and 3 provide an overview of the interrelationships between the prices and quantities. The supply prices of the composite commodities (PQS_c) are defined as the weighted averages of the domestically produced commodities that are consumed domestically (PD_c) and the domestic prices of imported commodities (PM_c), which are defined as the products of the world prices of commodities (PWM_c) and the exchange rate (ER) uplifted by *ad valorem* import duties (tm_c). These weights are updated in the model through first order conditions for optima. The suply prices exclude sales taxes, and hence must be uplifted by (*ad valorem*) sales taxes (ts_c) to reflect the composite consumer price (PQD_c). The producer prices of commodities (PXC_c) are similarly defined as the weighted averages of the prices received for domestically produced commodities sold on domestic and export (PE_c) markets; the weights are updated in the model through first order conditions for optima. The prices received on the export market are defined as the products of the world price of exports (PWE_c) and the exchange rate (ER) less any exports duties due, which are defined by *ad valorem* export duty rates (te_c).

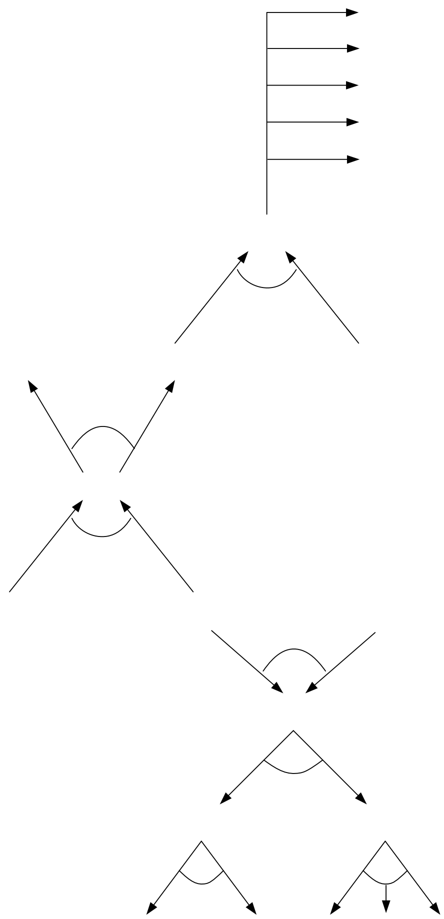
Figure 2 Price Relationships for a Standard Model with Commodity Exports



The average price per unit of output received by an activity (*PX*$_a$) is defined as the weighted average of the domestic producer prices, where the weights are constant. After paying indirect/production/output taxes (*tx*$_a$), this is divided between payments to aggregate value added (*PVA*$_a$), i.e., the amount available to pay primary inputs, and aggregate intermediate inputs (*PINT*$_a$). Total payments for intermediate inputs per unit of aggregate intermediate input are defined as the weighted sums of the prices of the inputs (*PQD*$_c$).

Total demands for the composite commodities, *QQ*$_c$, consist of demands for intermediate inputs, *QINTD*$_c$, consumption by households, *QCD*$_c$, enterprises, *QENTD*$_c$, and government, *QGD*$_c$, gross fixed capital formation, *QINVD*$_c$, and stock changes, *dstocconst*$_c$. Supplies from domestic producers, *QD*$_c$, plus imports, *QM*$_c$, meet these demands; equilibrium conditions ensure that the total supplies and demands for all composite commodities equate. Commodities are delivered to both the domestic and export, *QE*$_c$, markets subject to equilibrium conditions that require all domestic commodity production, *QXC*$_c$, to be either domestically consumed or exported.

Figure 3 Quantity Relationships for a Standard Model



The presence of multiple product activities means that domestically produced commodities can come from multiple activities, i.e., the total production of a commodity is defined as the sum of the amount of that commodity produced by each activity. Hence the domestic production of a commodity (QXC_c) is a CES aggregate of the quantities of that commodity produced by a number of different activities ($QXAC_{a,c}$), which are produced by each activity in activity specific fixed proportions, i.e., the output of $QXAC_{a,c}$ is a Leontief (fixed proportions) aggregate of the output of each activity (QX_a).

Production relationships by activities are defined by a series of nested Constant Elasticity of Substitution (CES) production functions. The nesting structure is illustrated in lower part of Figure 3, where, for illustration purposes only, two intermediate inputs and three primary inputs ($FD_{k,a}$, $FD_{l1,a}$ and $FD_{l2,a}$) are identified. Activity output is a CES aggregate of the quantities of aggregate intermediate inputs ($QINT_a$) and value added (QVA_a), while aggregate intermediate inputs are a Leontief aggregate of the (individual) intermediate inputs and aggregate value added is a CES aggregate of the quantities of primary inputs demanded by each activity ($FD_{f,a}$). The allocation of the finite supplies of factors (FS_f) between competing activities depends upon relative factor prices via first order conditions for optima. While the base model contains the assumption that all factors are fully employed and mobile this assumption can be, and often is, relaxed.

3.2. The Data

The data used for this study are arranged in three groups; a SAM that records all transactions between agents in the economy, a factor use matrix that identifies the quantities of each different factor used by each activity in the period to which the SAM refers, and 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 (see PROVIDE (2004) for a full description of the South Africa SAM database). The model SAM has 39 commodity groups (11 and 10 for agricultural and food commodities respectively), 37 activity groups (9 and 10 for agricultural and food activities), 14 factor groups – 12 types of labour plus land and capital, 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 Appendix Table A1.

A feature of the SAM that justifies emphasis here is the treatment of activities and specifically agricultural activities. The SAM uses a supply and use structure[3] that allows for

3 By definition each activity in an input-output structure produce a single commodity and each commodity is produced by a single activity.

the possibility that all activities can produce multiple products, which is the case for all activities in this SAM. Agricultural activities are defined by reference to regions of the country; ideally this would be by agronomic region but the agricultural census data are by political region. This classification of agricultural activities has, *inter alia*, a number of implications: each agricultural activity can produce a range of commodities; land is specific to each agricultural activity and cannot be transferred to another use; 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 analyses of the South African sugar industry in the context of increased liberalisation of the international sugar market; the scenarios are relatively straightforward and derive from the discussion above. Any substantive liberalisation of global sugar trade, particularly if it was accompanied by sustained reductions in the levels of domestic support in the EU and USA, would be expected to result in an increase in the world price (export and import) of sugar and sugar products as the proportion of sugar traded on a ‘free’ market increases (Mitchell, 2004). However increased liberalisation of global sugar trade is likely to increase the degree of competition and hence provide a strong incentive for the South African sugar industry to increase its efficiency. Hence there three sets of experiments

- sugar trade liberalisation that manifests as increases of up to 50 percent in the export price of South African sugar;[4]
- improvements of up to 10 percent in the efficiency with which cane is transformed into raw sugar (effectively a reduction in the TCTS ratio); and
- a combination of increases of up to 50 percent in the world price of sugar and improvements of up to 10 percent in the efficiency of transforming cane into raw sugar.

All the policy experiments are run twice; in the first cycle it is assumed that South Africa is a price-taker on a newly liberalised global sugar market while in the second cycle it is assumed that South Africa is a sufficiently large producer and exporter of sugar to cause the world price to decline as it increases exports.

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4 Mitchell (2004) reports estimates of up to 40 percent increase in world sugar prices as a result of global (multilateral) liberalisation.

4.2. Model Closure Rules

The model closure rules were selected with the objective of providing a realistic representation of the South African economy and can be categorised under six headings.

4.2.1. Foreign Exchange Market Closure

The foreign exchange market is assumed to clear via a flexible exchange rate and therefore the external balance – surplus/deficit on the current account – is assumed to be fixed. For all imports South Africa is assumed to be a price taker on global markets; hence it can import any quantity of a particular good or service at a constant price (in terms of foreign currency units). But on the export markets South Africa is assumed to have some power over the world price of gold; hence it is assumed that South Africa faces a downward sloping export demand curve for gold, with a constant price elasticity of demand of – 0.5 – the more gold South Africa exports the lower the price it receives per unit of gold exported.

South Africa is also assumed to face a downward sloping export demand curve for sugar exports, with a constant price elasticity of demand of – 0.2. However unlike the other closure rules for the foreign exchange market this closure rule is relaxed in one sequence of the simulations.

4.2.2. Investment-Savings Closure

The capital account – investment and savings – is closed by assuming that the share of domestic absorption accounted for by investment, in terms of expenditure, remains constant. The equilibriating variable is therefore a change in the savings rate; in this case the savings rates of all households and incorporated business enterprises are allowed to vary equiproportionately.

4.2.3. Government Closure Rules

The government account is closed by variations in the level of government borrowing/savings. All tax rates are assumed to remain constant and the government is assumed to consume a fixed share of domestic absorption. The impacts of the policy shocks upon government revenue are small and hence the impact upon government borrowing is small; consequently the impact of allowing the government savings to vary is marginal.

4.2.4. Factor Market Closure

The factor market closure involves different treatments for different factors. The land factor is assumed to be activity specific and the demand is fixed; this reflects the fact that the agricultural activities are defined by specific locations and hence cannot change the amount of land available. The labour categories are subdivided into two broad groups – skilled and unskilled (see Table 2). Skilled labour is assumed to be fully employed and mobile across economic activities and hence the equilibriating variable is the wage rate. The supply of unskilled labour is assumed to be perfectly elastic hence activities can consume as much labour as they want at a constant wage rate. The equilibriating variable is the quantity of unskilled labour employed. For physical capital two alternative scenarios are explored; a short run scenario where the quantity of capital used by each activity is fixed, and a long run scenario where the total quantity of capital is fixed but it is mobile across activities.

Table 2 Fully Employed and Unemployed Labour Categories

Fully Employed Labour	Unemployed Labour
African skilled labour	African unskilled labour
Coloured skilled labour	African manual labour
Asian skilled labour	Coloured unskilled labour
Asian unskilled labour	Coloured manual labour
Asian manual labour	
White skilled labour	
White unskilled labour	
White manual labour	

4.2.5. Model Numéraire

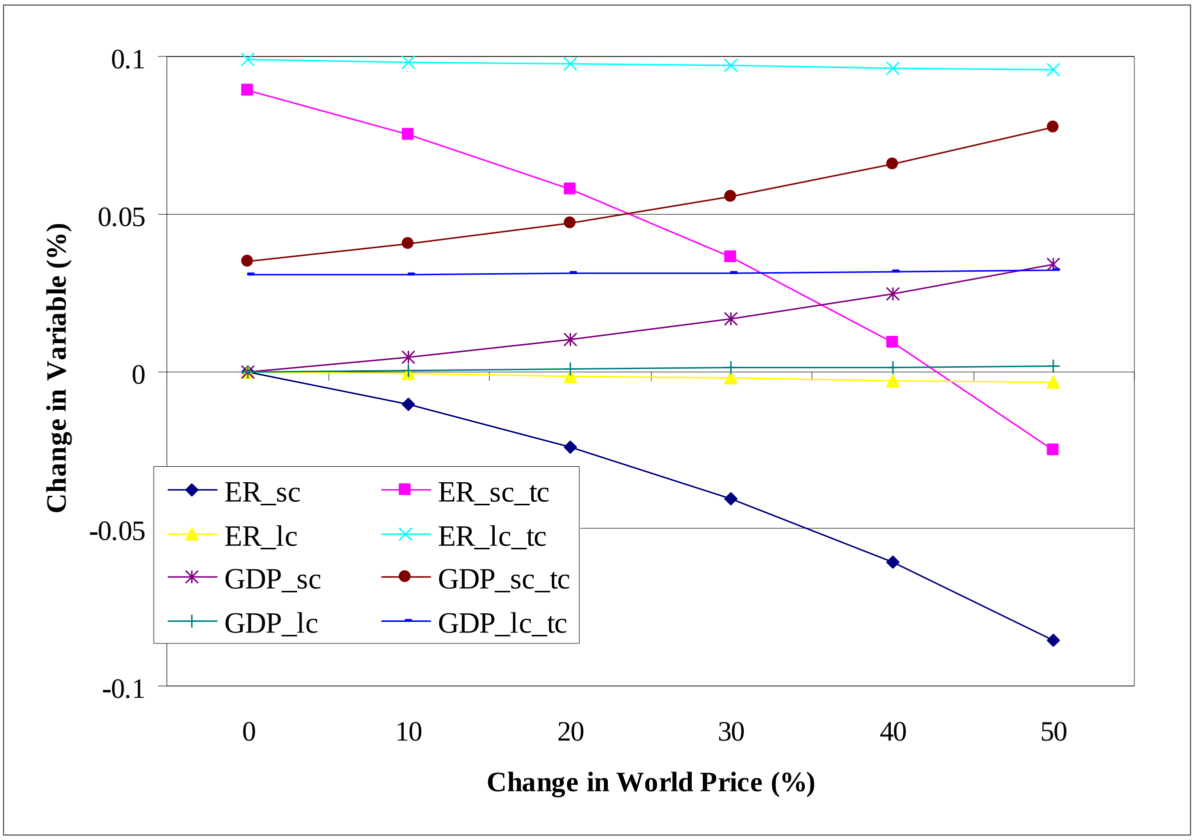
The model numéraire is the consumer price index; hence all the value results are in real terms.

4.3. Results and Analyses

Despite the agricultural sector accounting for a relatively small share of GDP, some 4 percent, and the sugar industry being a relatively small part of the agricultural sector, the liberalisation of the sugar trade has a noticeable impact upon GDP (see Figure 4). In the small country case and without technical change in sugar processing, GDP (GDP_sc) increases by up to 0.03 percent, this is more than doubled (0.078 percent) when there is technical change (GDP_sc_tc). The increase in exports associated with liberalisation (see below) causes the exchange rate to appreciate by 0.085 percent without technical change (ER_sc),[5] but with technical change (ER_sc_tc) it depreciates unless the change in the world price of sugar exceeds about 42 percent (the reasons behind this are explored below).

5 The exchange rate in the model is defined as the quantity of domestic currency required to purchase a unit of ‘world’ currency. Hence an appreciation of the exchange rate results in a reduction in the amount of domestic currency required to purchase a unit of world currency.

Figure 4 GDP and the Exchange Rate – Small vv Large Country Assumption with 10 percent change in TCTS

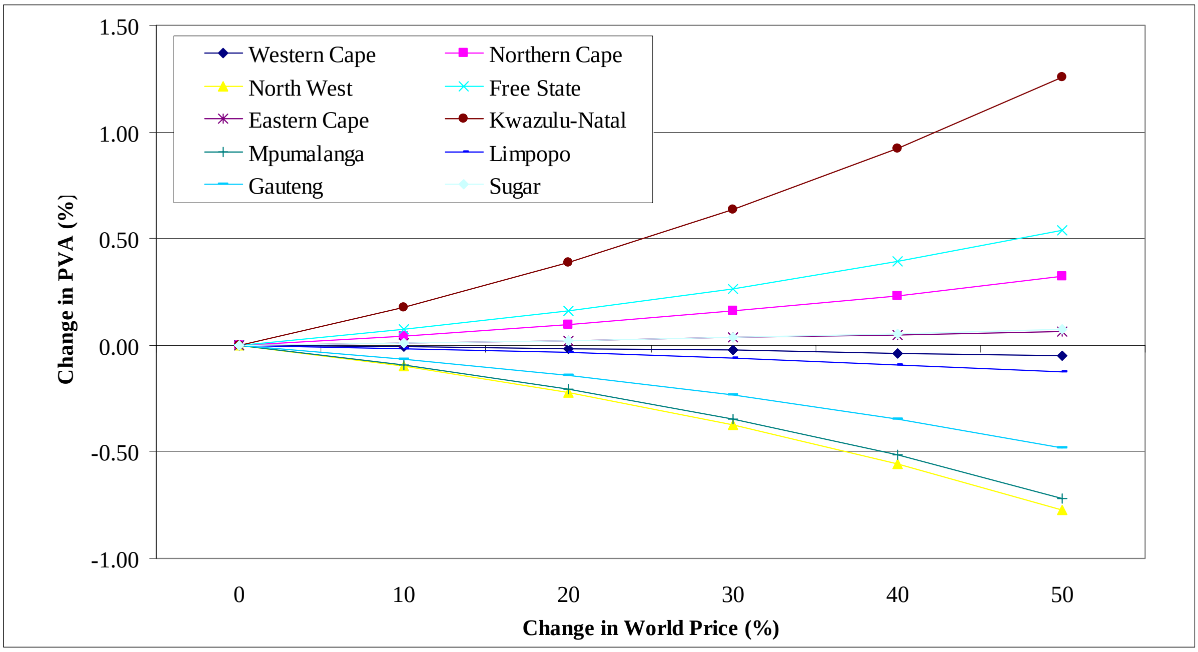


Source: Simulation results

The large country case produces a very different picture: without technical change in sugar processing the potential gains in GDP are cancelled out by the declining export price and hence the exchange rate is largely unchanged, whereas with technical change all the benefits, in terms of GDP, are realised from the technical change effects with which there is an associated depreciation of the exchange rate. Clearly there would have been increases in GDP if the price elasticity of demand for sugar exports had been larger, i.e., less negative. While this may be the case, the fundamental point remains unaffected: if increases in South African sugar exports exert any downward pressure on world prices some, and maybe all, of the potential benefits may be nullified.

Arguably of greater interest are the consequences of sugar trade liberalisation for agriculture in South Africa. *A priori* it might be reasonable to expect that agriculture in the provinces that produce sugar would benefit, while the implications for other provinces would be limited. These simulations indicate that the outcomes may be more complex. An important indicator of the implications for agriculture are the rates of return to aggregate primary inputs, i.e., the prices of value added, which indicate the extent to which activities seek to expand or contract as a result of the policy shock – these are reported for agricultural activities and the sugar processing industry in Figures 5 and 6. In the small country case, Figure 5, and without technical change the impact upon agriculture in KwaZulu-Natal confirms with expectations, the price of value added rises by up to 1.25 percent, but in contrast it falls by up to 0.72 percent in Mpumalanga, which is the other province that produces substantial amounts of sugar. Moreover the prices of value added vary appreciably across agriculture in different provinces, with the Northern Cape (up to 0.32 percent), the Free State (up to 0.54 percent) and the Eastern Cape (up to 0.07 percent) also gaining but with the Western Cape (up to -0.05 percent), Limpopo (up to -0.13 percent), North West (up to -0.77 percent) and Gauteng (up to -0.48 percent) losing.

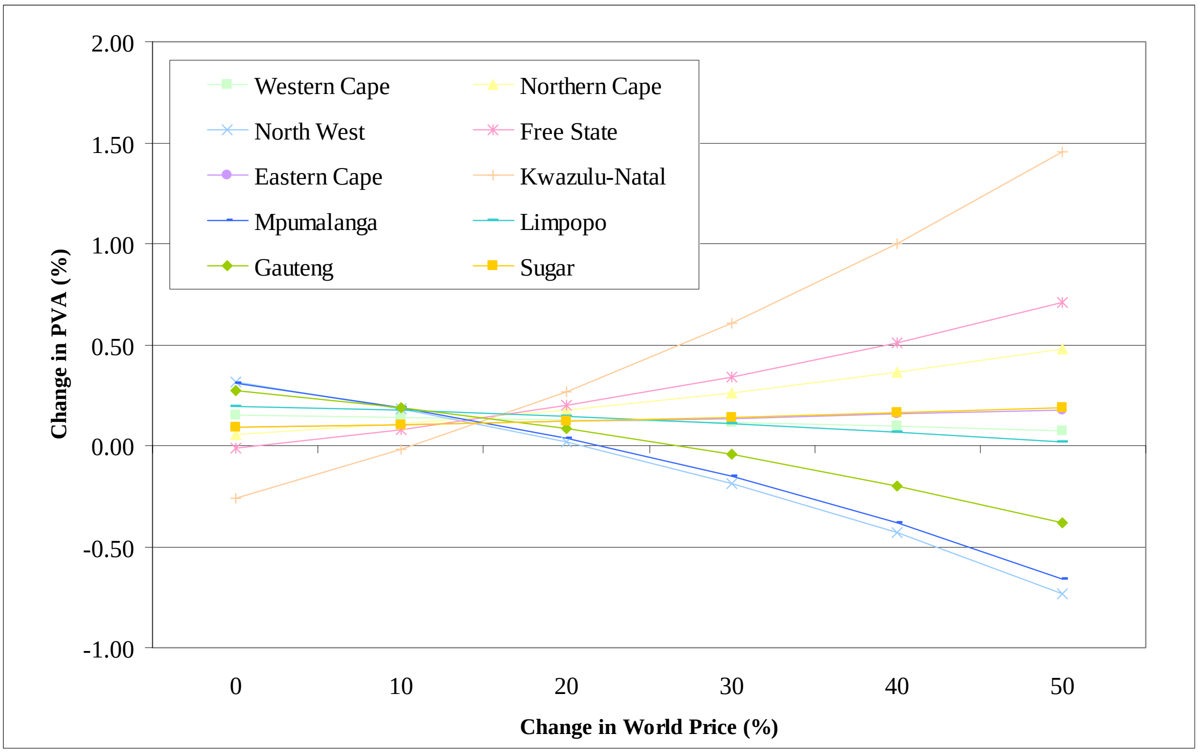
Figure 5 Price of Value Added (PVA) for Agriculture and Sugar Processing – Small Country Assumption without change in TCTS



Source: Simulation results

The generality of the results presented in Figure 5 are unaffected by the presence of technical change in sugar processing (see Figure 6). Technical change in sugar processing changes the starting point, with KwaZulu-Natal and the Free State (marginally) losing out if world prices remain unchanged and the other agricultural activities gaining. But as the world price of sugar increases so the same patterns of responses in PVA assert themselves; such that the overall impact of the change in technology is to cause a shift upwards in the PVA curves and move the point of intersection to when the world price has increased by about 15 percent.

Figure 6 **Price of Value Added (PVA) for Agriculture and Sugar Processing – Small Country Assumption with 10 percent change in TCTS**

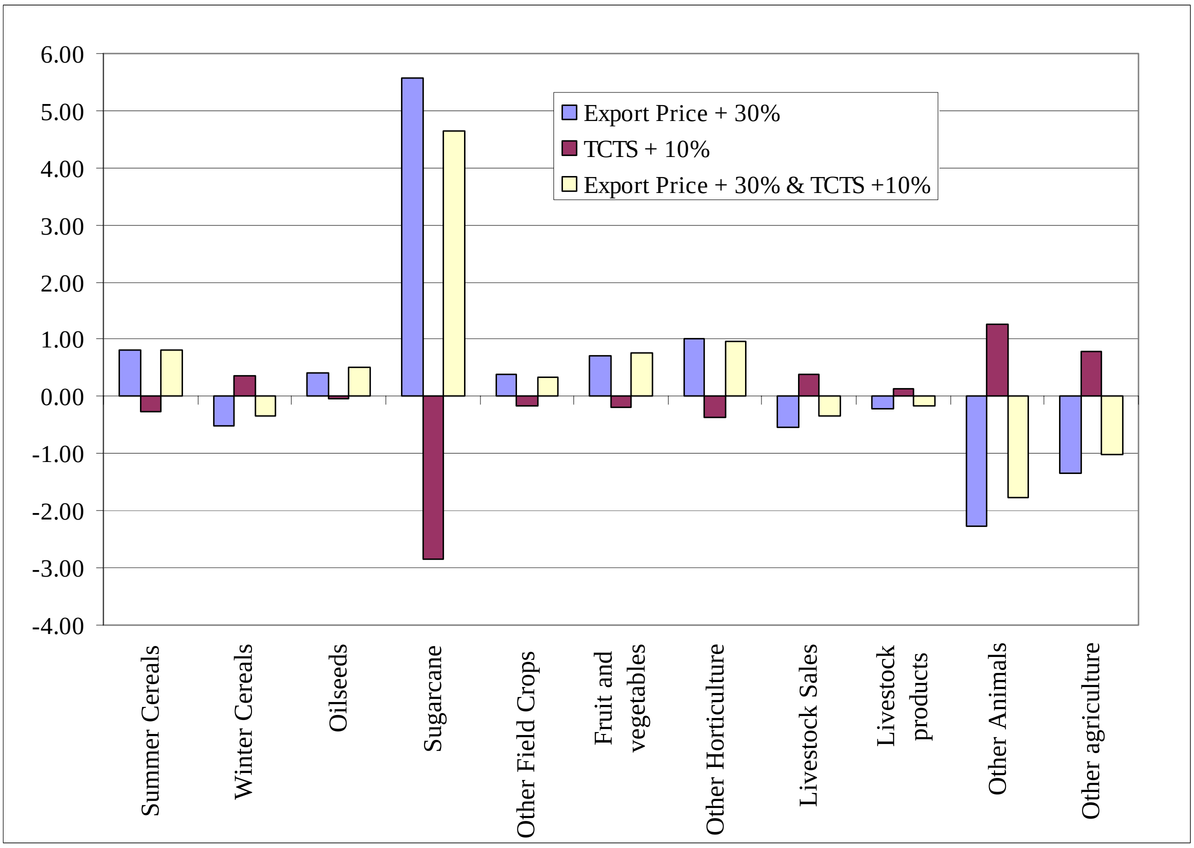


Source: Simulation results

The initially counterintuitive nature of these results is a consequence of the fact that the agricultural activities, defined by province of location, are multi product activities, i.e., they produce a range of agricultural commodities. The liberalisation of the sugar trade causes changes in the exchange rate, which means that the prices of all traded commodities are subject to change and therefore the prices received by domestic producers will change (see Figure 7 for the combined effects of a 30 percent change in export price and a 10 percent improvement in the TCS ratio).[6] Apart from sugarcane all the changes are relatively small but in combination with differences in the output mix of the different agronomic regions they are sufficient to generate a range of different 'average' prices received by each province for their composite outputs (see Figure 8). As can be seen the signs on the changes in prices for composite outputs by each agricultural activity explain the signs on the prices of value added – the results for the increase in export price correspond to the results in Figure 5, while the results for the change in export prices and technical change correspond to the results in Figure 6.

6 It is worth noting that the technical change reduces the (derived) price of sugarcane, which is to be expected since relatively less is demanded as an input, but that the combined effects of the increased export price and technical change are appreciably greater than the sum of the component parts.

Figure 7 Prices of Agricultural Commodities Sold on the Domestic Market– Small Country Assumption with and without 10 percent change in TCTS



Source: Simulation results

Consequently it is the differences in output mix produced in each agronomic region, in combination with the price changes driven initially by the changes in the exchange rate and to a lesser extent the small income effect, that cause the effects of sugar trade liberalisation to have repercussions for South African agriculture beyond those areas that produce sugarcane. This is especially relevant in Mpumalanga, where the impact of technical change alone increases the activity price, which is the reverse of the case in KwaZulu-Natal while the trade liberalisation effect is to reduce the activity price, which again is the reverse of the case for KwaZulu-Natal. A further interesting effect is how technical change in the sugar industry increases the composite activity prices across all provinces, and that these price increases are sufficient in the case of the Western Cape and Limpopo (just) to cancel out the negative effect of the exchange rate.[7]

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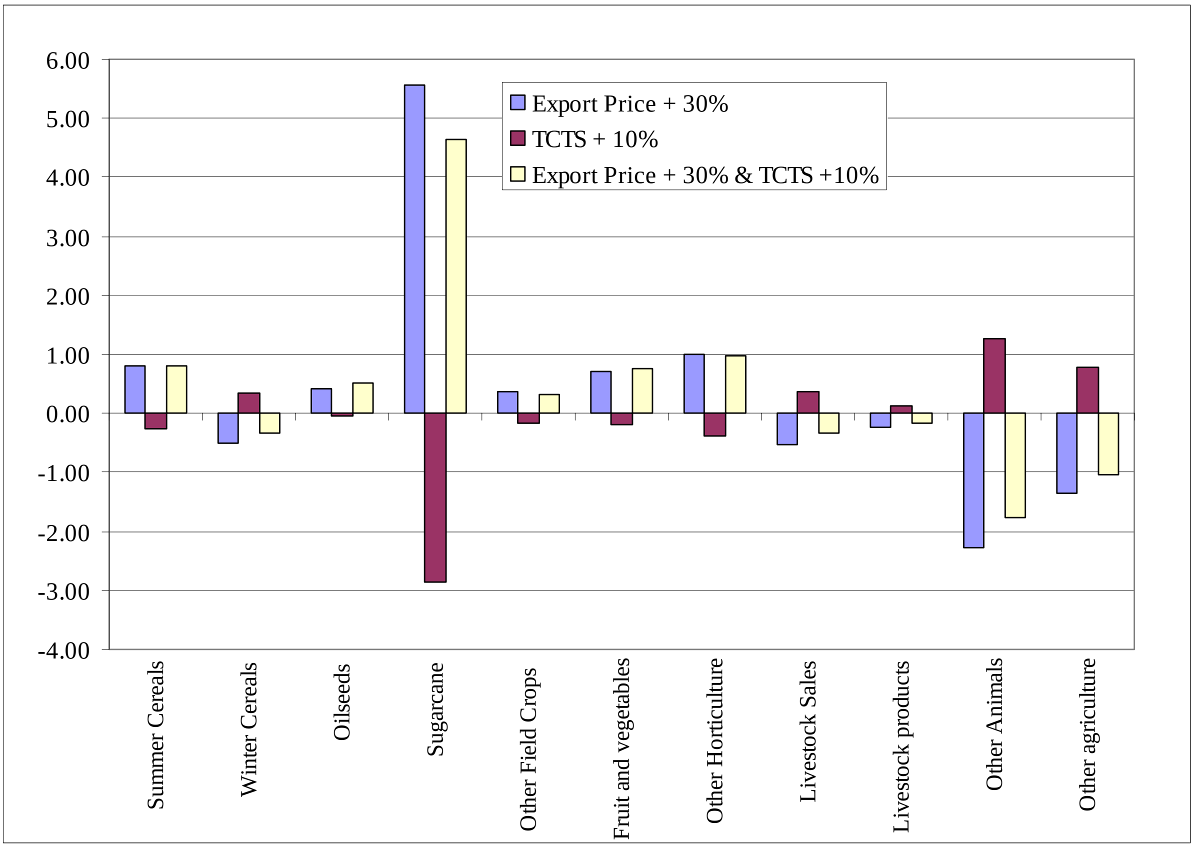
7 There is also an income effect associated with the increase in GDP and welfare (see below) that will result in a minor expansion of agricultural activity.

Figure 8 **Activity Prices for Agricultural Activities – Small Country Assumption with and without 10 percent change in TCTS**

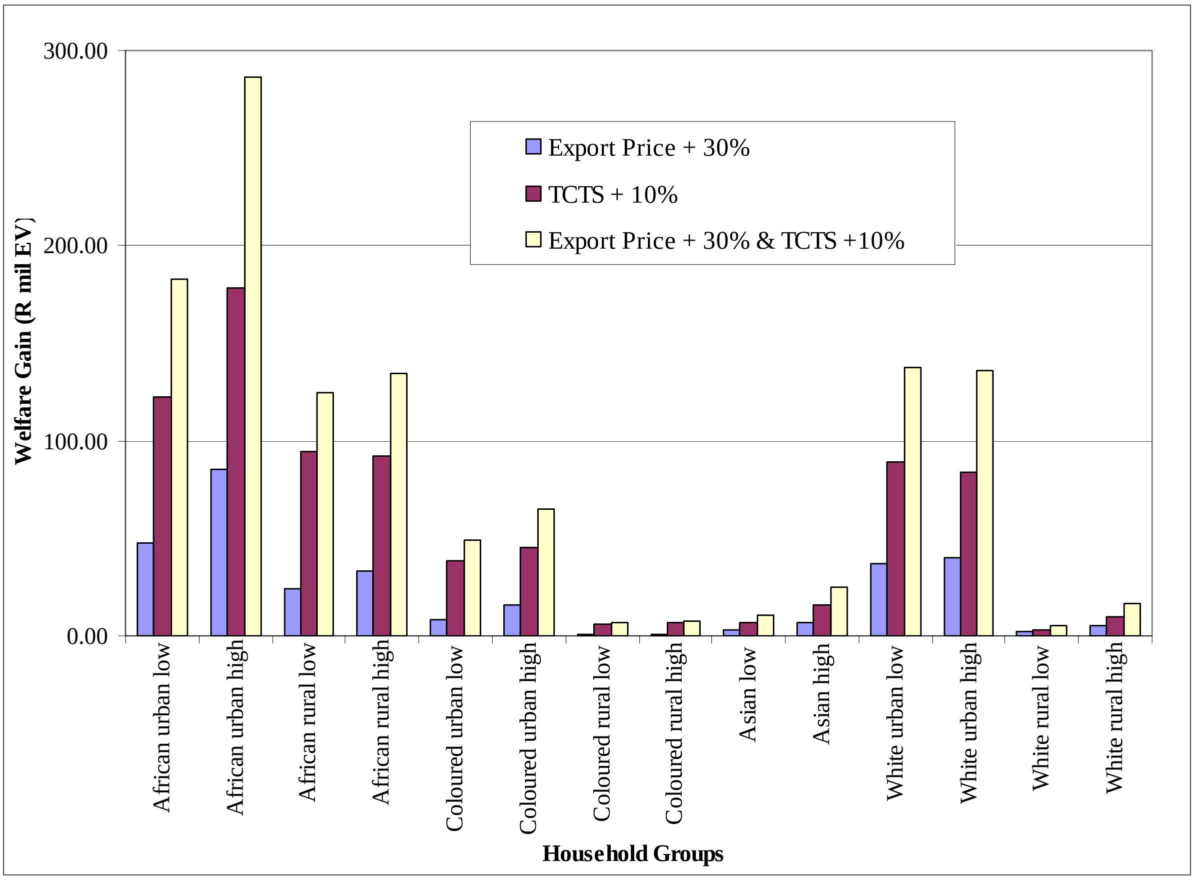


Source: Simulation results

These price changes stimulate substantial changes in factor demand by agriculture across the provinces. For the combined effects of a 30 percent change in export price and a 10 percent improvement in the TCS ratio these range from plus 5.2 percent to minus 2.9 percent for African labour in KwaZulu-Natal and North-West respectively (Figure A1), from plus 1.9 percent to minus 0.4 for Coloured labour in the Free State and in the Western Cape (Figure A2) and from plus 4.8 percent to minus 2.9 for White labour in the KwaZulu-Natal and in the North West (Figure A3). Even allowing for the relatively small proportions of the South Africa workforce that are engaged in agriculture these changes in factor demands represent a substantial structural change that may take some time to be effected.

If the new equilibria are achieved there are however across the board welfare gains for the (representative) households. Under the maintained small country assumption the total welfare gains (equivalent variation) are R311m, R792m and R1,186m for the 30 percent increase in the world price, the 10 percent increase in technical efficiency and the combination of the two effects respectively. The distribution of these gains shows some evidence of being biased towards the lower income households – see Figure 9 – since the gains are concentrated among African and Coloured households, but there are also substantial welfare gains for the Urban White Households who have appreciably higher incomes and are fewer in number. The across the board welfare gains are also found when there is a downward sloping export demand curve for sugar, although the total gains are substantially reduced (R18m, R711m and R728m for the 30 percent increase in the world price, the 10 percent increase in technical efficiency and the combination of the two effects respectively), the distribution of the gains is remarkably similar – see Figure 10.

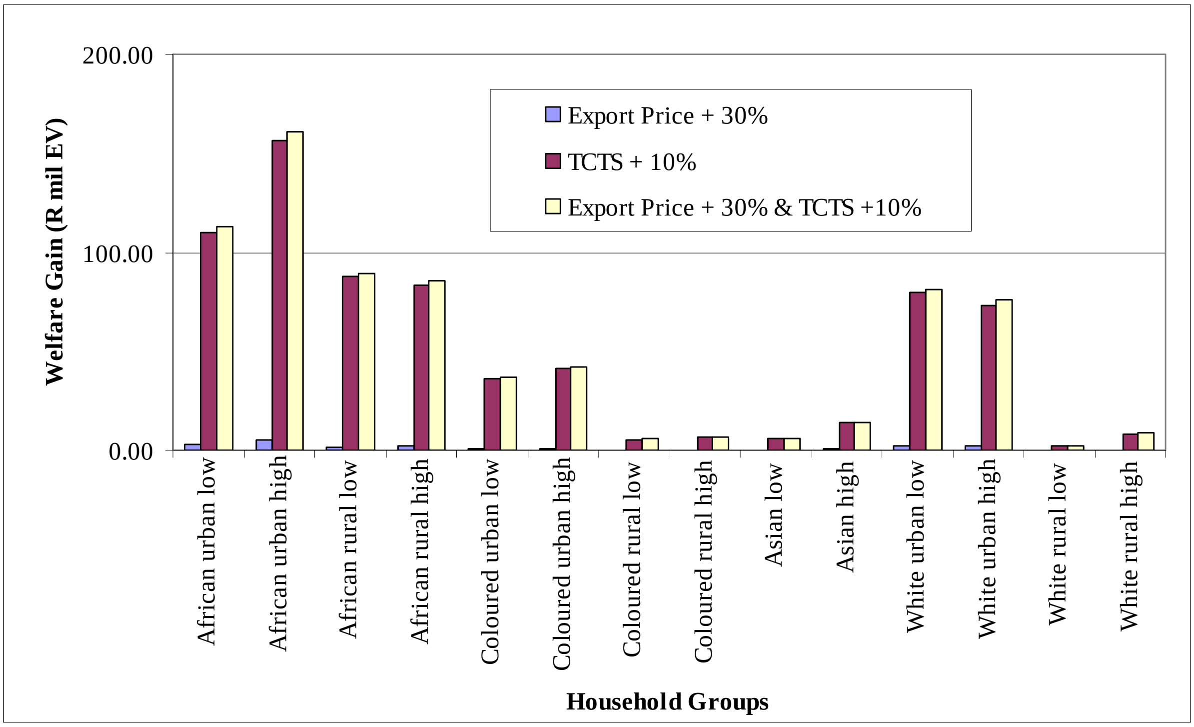
Figure 9 Household Welfare with Small Country Assumption (R million EV)



Source: Simulation results

An important feature of the welfare gains is the extent to which they demonstrate both the relative importance of and the complementarity of the trade liberalisation and technical efficiency gains. In the small country case the impacts of the efficiency gain on welfare are greater than the trade liberalisation effects for all households and the welfare effects of the combined simulations are greater than the sum of the two separate components. In the large country case the welfare effects of the trade liberalisation scenario are close to zero, which is not surprising, but the benefits from technical change are virtually unaffected.

Figure 10 Household Welfare with Large Country Assumption (R million EV)



Source: Simulation results

These welfare effects are a combination of income and prices effects, but in the main the income effects are relatively small and hence the primary factor behind the welfare gains is the change in relative (consumer) prices – see Appendix Figures A4 and A5. However the consumer price changes differ appreciably between the small and large country cases – this is to be expected since the large country case is configured such that the exchange rate effect is largely nullified. Nevertheless the overall effect is positive in both cases.

5. Conclusions

The results in this study derive from the maintained assumption that global trade in sugar will be liberalised. In a market so characterised by market interventions, bilateral trade agreements, domestic support mechanisms and political positioning it is difficult to make a strong argument that trade liberalisation is imminent. However there is some evidence to suggest that the OECD countries are beginning to reduce the extent to which they intervene in sugar markets, e.g., the on-going downward reduction in the extent to which the EU's domestic prices exceed world prices, and hence that some liberalisation is likely to been seen over the next few years. Moreover, recent (mid 2004) WTO rulings about the EU's subsidies for sugar producers, especially with respect to the effects of subsidies associated with exports that match the preferential imports of sugar for the ACP (African, Caribbean and Pacific) group of countries suggest pressure to liberalise sugar trade may be growing more meaningful. Importantly the results from these analyses indicate that the benefits to South Africa from the liberalisation of global sugar trade may be appreciable and hence that there are substantial reasons for South Africa to argue for liberalisation both multilaterally, through the WTO, and bilaterally in its negotiations with OECD trading partners. In the former case there is clearly an argument for further analyses using a global model to assist in the identification of South Africa's natural allies in multilateral negotiations.

The outcomes for South Africa of sugar trade liberalisation are not however unambiguously positive. While all the representative household groups, on average, gain under all the scenarios considered here there are likely to be some households that lose out. Predominately these are likely to be those households that are affected directly by the reorganisation of agricultural production across the different provinces of South Africa, with the negative effects being most concentrated in Gauteng, Mpumalanga and the North West. In some instances these negative consequences may be quite severe since they will be associated with job losses. On the other hand these negative effects seem to be more than offset by the positive effects that are most concentrated in KwaZulu-Natal, the Free State and Northern Cape.

A critical aspect of the results is the degree to which welfare gains can be realised through technical change. These results indicate that there are strong incentives from the consumers' perspective to foster improvements in the TCTS ratio despite the potentially negative consequences for producers of sugarcane. This begs two questions. First, can the South African sugar industry develop to such an extent that it can reduce the TCTS and second, how will changes in the structure of cane production, especially the move towards production on smaller family farms rather than large estates, affect the TCTS ratios. This latter is especially relevant to the land reform issue since there is some evidence that land under sugarcane production is particularly favoured for redistribution. These results suggest that land reform in the sugarcane growing areas needs to pay particular attention to the coordination of cane growing, cutting and milling to maintain the profitability of land reform farms.

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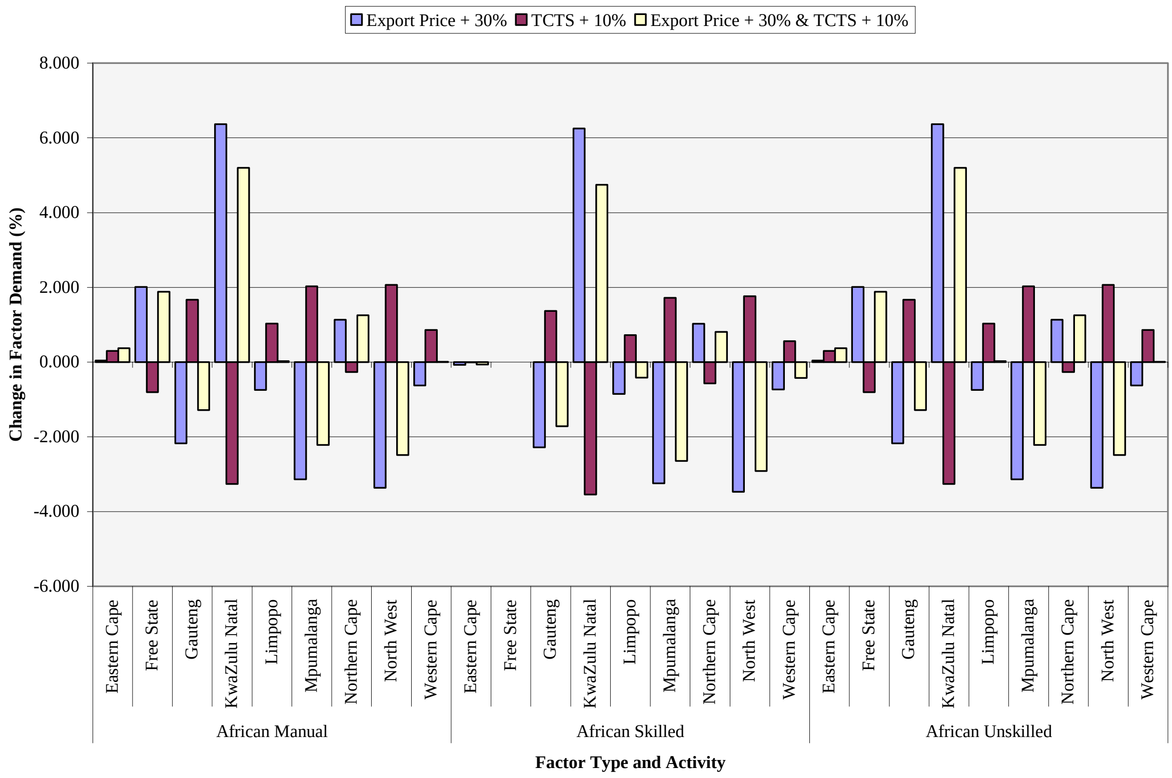
7. Appendices

Table A1 SAM Accounts for this Study

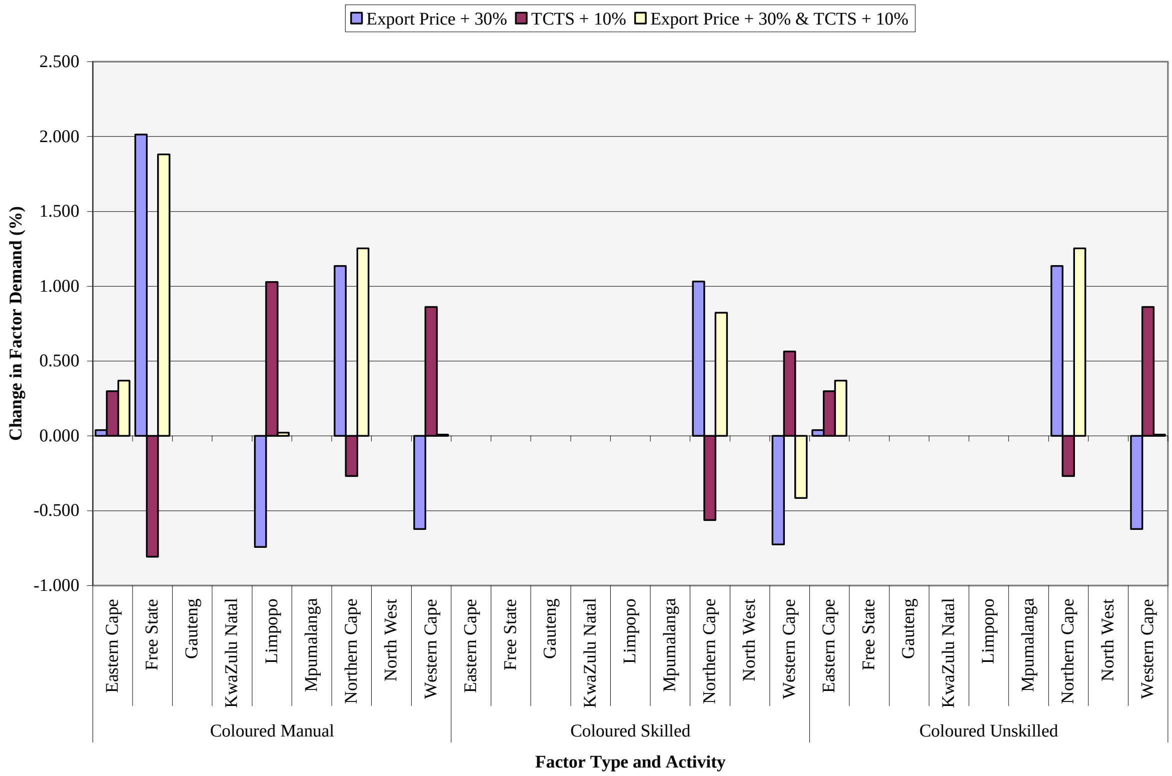
Commodities	Activities	Factors, households and other
Summer Cereals	Agriculture Western Cape	Gross operating surplus
Winter Cereals	Agriculture Northern Cape	Land
Oilseeds	Agriculture North West	African skilled labour
Sugarcane	Agriculture Free State	African unskilled labour
Other Field Crops	Agriculture Eastern Cape	African manual labour
Fruit and vegetables products	Agriculture KwaZulu-Natal	Coloured skilled labour
Other Horticulture	Agriculture Mpumalanga	Coloured unskilled labour
Livestock Sales	Agriculture Limpopo	Coloured manual labour
Livestock products	Agriculture Gauteng	Asian skilled labour
Other Animals	Mining	Asian unskilled labour
Other agriculture	Meat	Asian manual labour
Mining	Fruit	White skilled labour
Meat products	Oils and dairy	White unskilled labour
Fruit and vegetables products	Grain mills	White manual labour
Oils fats and dairy products	Animal feeds	African urban low
Grain mill products	Bakeries	African urban high
Animal feeds	Sugar	African rural low
Bakery products	Confectionery	African rural high
Sugar products	Other food	Coloured urban low
Confectionery products	Beverages & tobacco	Coloured urban high
Other food products	Textile and leather products	Coloured rural low
Beverages and tobacco products	Wood and Paper	Coloured rural high
Textile and leather products	Chemical Products	Asian low
Wood and Paper	Rubber and Plastic	Asian high
Chemical Products	Non metal products	White urban low
Rubber and Plastic	Metal products	White urban high
Non metal products	Machinery	White rural low
Metal products	Electrical machines	White rural high
Machinery	Vehicles	Import duties
Electrical machines	Miscellaneous manufactures	Export taxes
Vehicles	Utilities	Sales taxes
Miscellaneous manufactures	Construction	Production taxes
Utilities	Trade	Factor taxes
Construction	Transport services	Direct income taxes
Trade services	Other services	Government
Transport services	Government services	Enterprises
Other services	Domestic Services	Savings
Government services		Stock Changes
Domestic Services		Rest of World

Figure A1 Factor Demand by Agriculture for 30 percent Change in World price with and without 10 percent Change in TCTS– African Labour



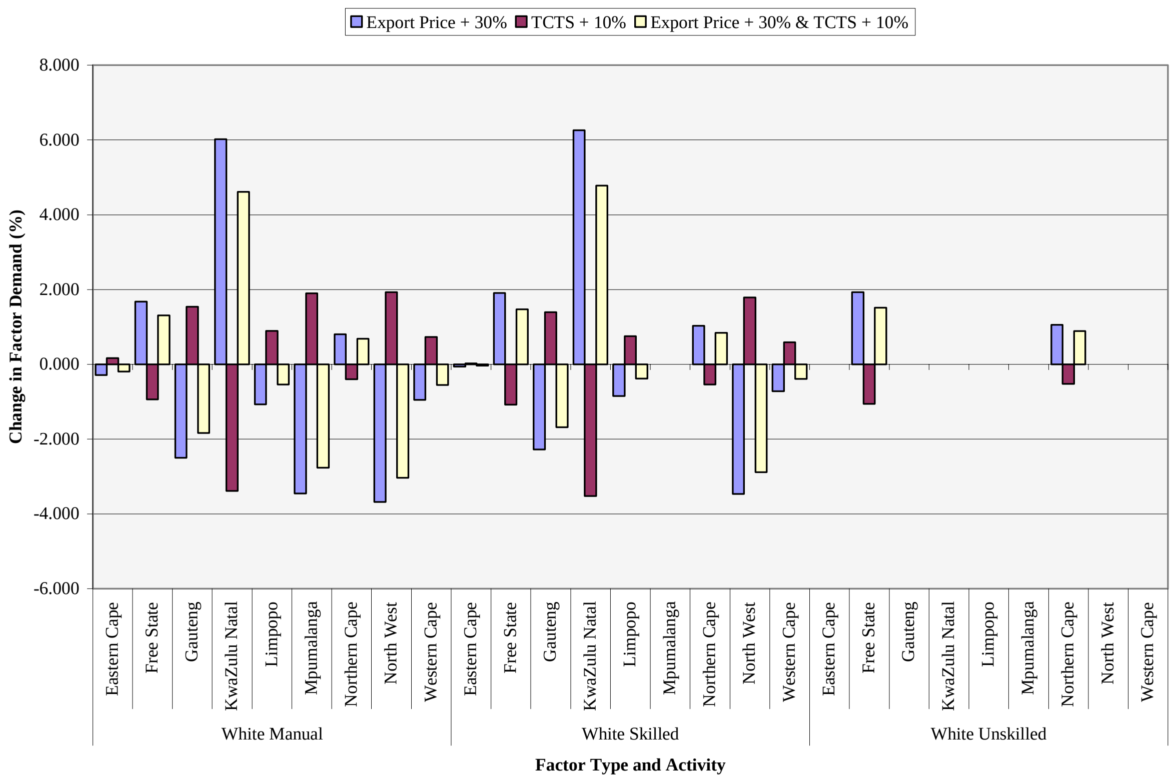
Source: Simulation results

Figure A2 Factor Demand by Agriculture for 30 percent Change in World price with and without 10 percent Change in TCTS– Coloured Labour



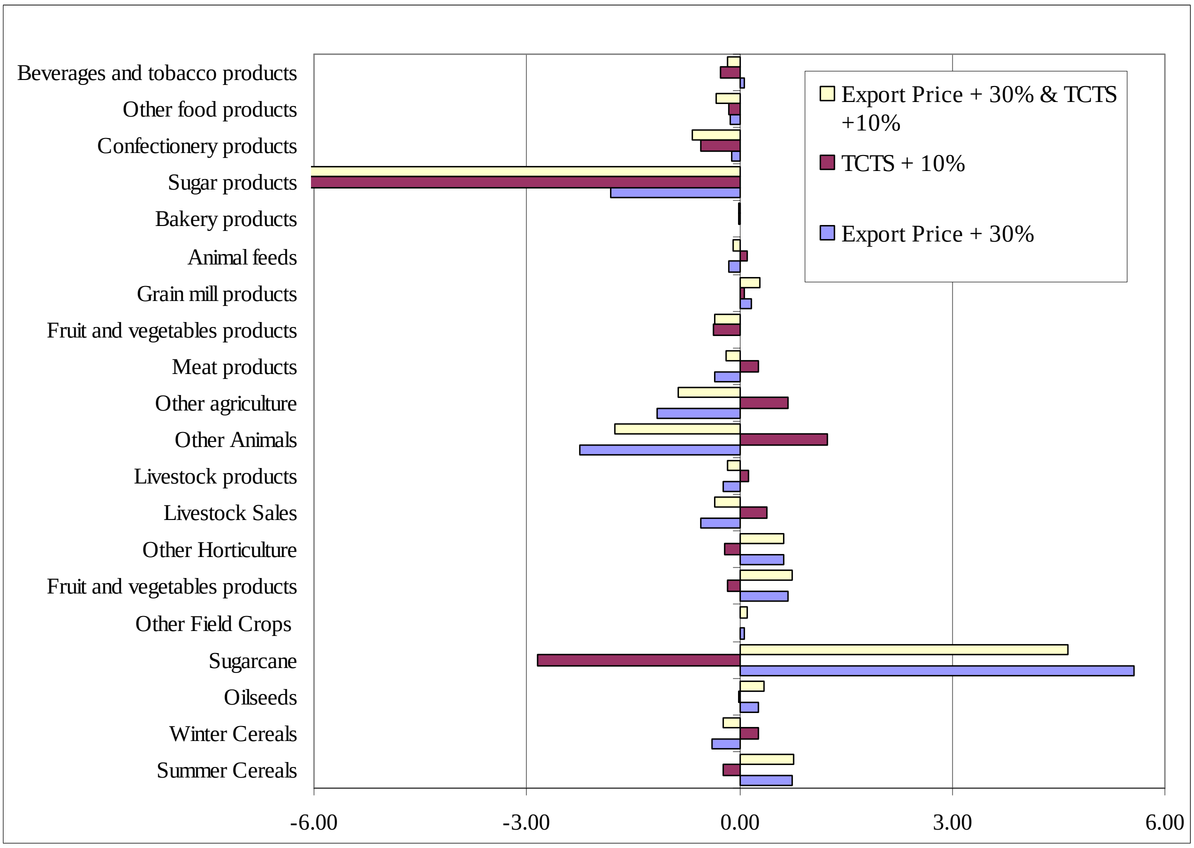
Source: Simulation results

Figure A3 Factor Demand by Agriculture for 30 percent Change in World price with and without 10 percent Change in TCTS– White Labour



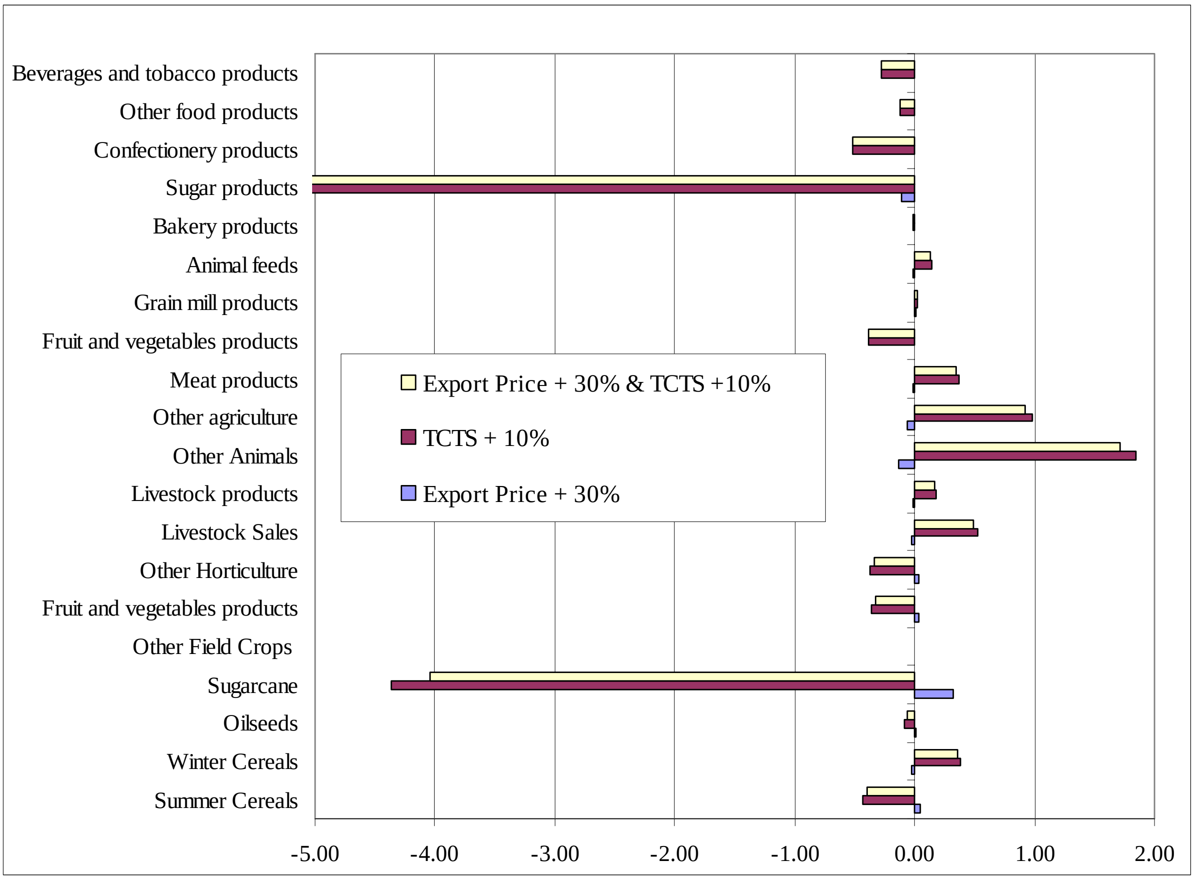
Source: Simulation results

Figure A4 Selected Consumer Price Changes with Small Country Assumption (%)



Source: Simulation results

Figure A5 Selected Consumer Price Changes with Large Country Assumption (%)



Source: Simulation results