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Trade Policy Reforms in the Cereals Sector of the SADC Region: Implications on Food Security

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Abstract

This study evaluates the welfare implications of tariff reforms in the cereals sector of the SADC region. Applying the global simulation model (GSIM), a multi-country partial equilibrium model, to the cereals industries of thirteen SADC countries, the study computes price and welfare effects of tariff reforms on different economic groups in each country, and evaluates responsiveness to external supply shocks. Results indicate that on net, elimination of intra-regional tariffs is welfare reducing for the region - a robust result as indicated by the sensitivity tests. South Africa emerges as the sole beneficiary of intra-regional tariff elimination, with positive net welfare gains attained through higher producer surplus; whereas the rest of SACU experiences losses in consumer surplus, and the rest of SADC experiences losses in producer surplus. Imports from the rest of the world drop for most net-importer SADC countries, whereas trade with the SADC region generally increases, indicating that both trade diversion and trade creation result from these tariff reforms. The negative net welfare effects suggest that the trade diversion effects exceed the trade creation effects for most of SADC. Larger, positive welfare effects are expected for all of SADC, except South Africa and Zimbabwe, when countries implement indiscriminate reform of MFN tariff rates, although gains come at major costs to regional producers. Imports from both the region and the world are also expected to increase. Tariff reforms also seem to serve the purpose of spreading price and quantity risk, albeit meagerly, from supply shocks generated within the region, making it less intense in countries of origin, and more intense for the rest of SADC.

1. Introduction

1.1 Research Problem

Policy makers in the southern Africa region have the big challenge of reconciling domestic and trade policies, in order to maintain stability in food supply and prices. Improving intra-regional trade, through reduction of tariff and non-tariff barriers to regional trade has been widely advocated as a critical piece in the food insecurity puzzle. According to the Food, Agriculture and Natural Resources (FANR) arm of the SADC Secretariat, regional supplies (production plus opening stocks) in any given season are enough to cover regional consumption needs, so that facilitating freer movement of grains would aid in meeting isolated shortfalls (SADC 2003). Moepeng 2003, also argues that 'free trade in the region would facilitate large-scale production of white maize in SADC countries with comparative advantage, and improve regional food security, even in drought period, because regional stocks can be made available to food importing countries such as Botswana.' Simplification and harmonization of trade regulations has been promoted as a response mechanism to drought emergencies in the region, (Tschirley et al 2004, Mano 2003), while integrating the region with the global markets is recognized as a critical component of a comprehensive food strategy (World Bank DTIS Mozambique, 2004 and Malawi, 2002). Regional trade is also thought to be key to efforts to intensify production in surplus producing countries (Arlindo and Tschirley, 2003). In addition, the vast amounts of research in understanding trade policy (SADC FANR, 1996-2005), and monitoring cross-border grain movements (FEWS/WFP, 2004-2005), seems to indicate significant trade flows and price responses to market forces.

Despite these general pro-trade sentiments, and the numerous attempts to understand the food sector of the SADC region, the lack of a clear understanding of the welfare effects of specific trade policy options on specific economic groups, necessary to reduce ambiguity in policy recommendations and to accurately anticipate potential negative effects, has forced countries to remain significantly closed with regards to trade in food commodities (Mano et al, 2003). The tendency to control food markets in poor countries, however, is not completely unwarranted, considering that large segments of the populations live at the verge of inadequate nutrition (about a third of the SADC population, World Development Indicators, 2005) and are therefore susceptible to minor shifts in supply or prices. Openness has been thought to exacerbate susceptibility to external shocks – such as the risk of excessive exports in regional shortage periods – that may in turn lead to price instability and threaten food security (Arlindo and Tschirley, 2003). Moreover, the implications of regional market openness are generally complex, and could have critical effects on food security. Efforts to quantify micro and macro level expected gains from freer trade in grains in southern Africa have been limited, and specific effects of trade reforms remain largely unknown. Previous literature in this area has tended to focus on evaluating welfare effects at a broad macro level, rather than specific industry level (Chauvin and Gaulier 2002, Poonyth *et al* 2002, Madola *et al* 2002, Kahuika 2002, Jere 2002, Mafusire 2002, Mukherje and Robinson 1996). According to Mano et al 2003:

> 'There is an urgent need for SADC countries to understand the complex implications of regional free trade agreements on agricultural policies and on their national and sub-national food economies. Countries must embrace the concept that achieving food self-sufficiency will not necessarily enhance their food security status if this is achieved at high economic costs……Regional free trade agreements, as facilitated through SACU, the COMESA Treaty and the SADC Protocol on Trade, can help SADC countries achieve national food security through regional trade integration.' Mano, Isaacson and Dardel, 2003.

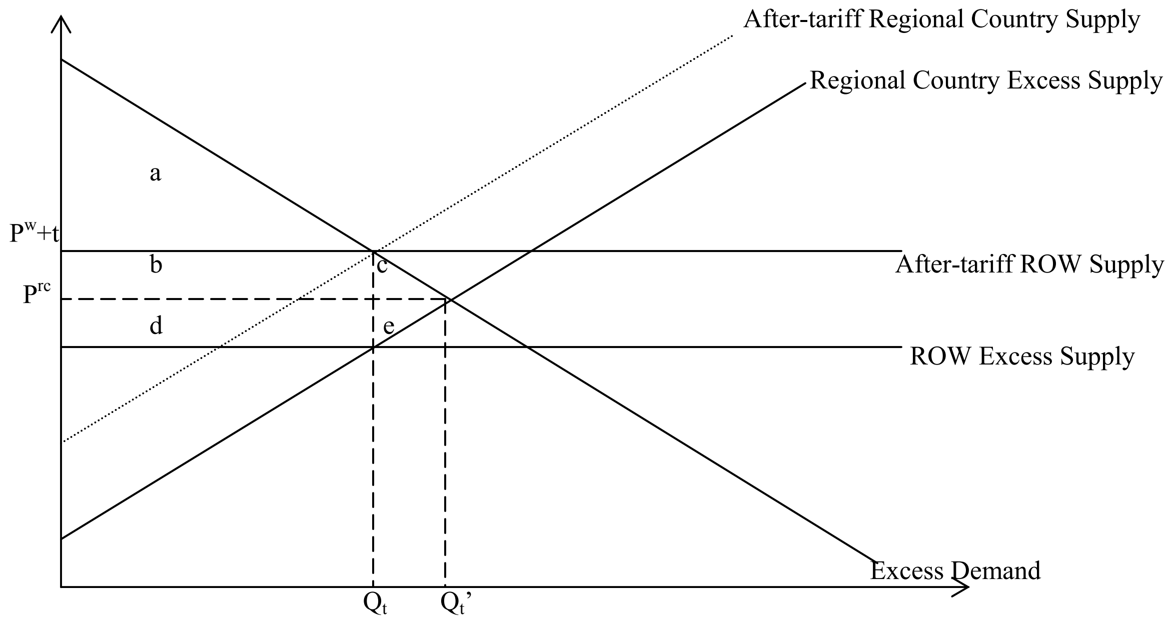
This study contributes towards bringing quantitative evidence into the trade – food policy debate.

1.2 Objectives and Hypotheses

The purpose of the study is to evaluate the welfare implications of freer trade policies in the cereals sector of the southern Africa region, with specific focus on the effects of tariff reforms on prices, incomes, production levels and consumption levels. The specific objectives are to (1) compute the expected price responses to tariff reforms in the cereals sector, (2) assess the potential welfare implications for consumers and producers in each country in the region, and (3) establish the potential effect on vulnerability (price responsiveness) to external supply shocks.

Regional integration is expected to lead to at least two types of responses in trade flows between countries participating in the regional free trade agreement (FTA) and the rest of the world. First, regional integration can lead to trade creation: when the removal of tariffs allows a member country of the FTA to increase its imports from its trading partner, also a member of the FTA, without reducing its imports from the rest of the world (ROW). Trade creation leads to increased overall trade volumes, thus is strictly beneficial for the countries within the FTA, and at least as beneficial for the rest of the world. The effects of trade creation on a small-country importer from the formation of an RIA are presented in Figure 1.

FIGURE 1: TRADE CREATION

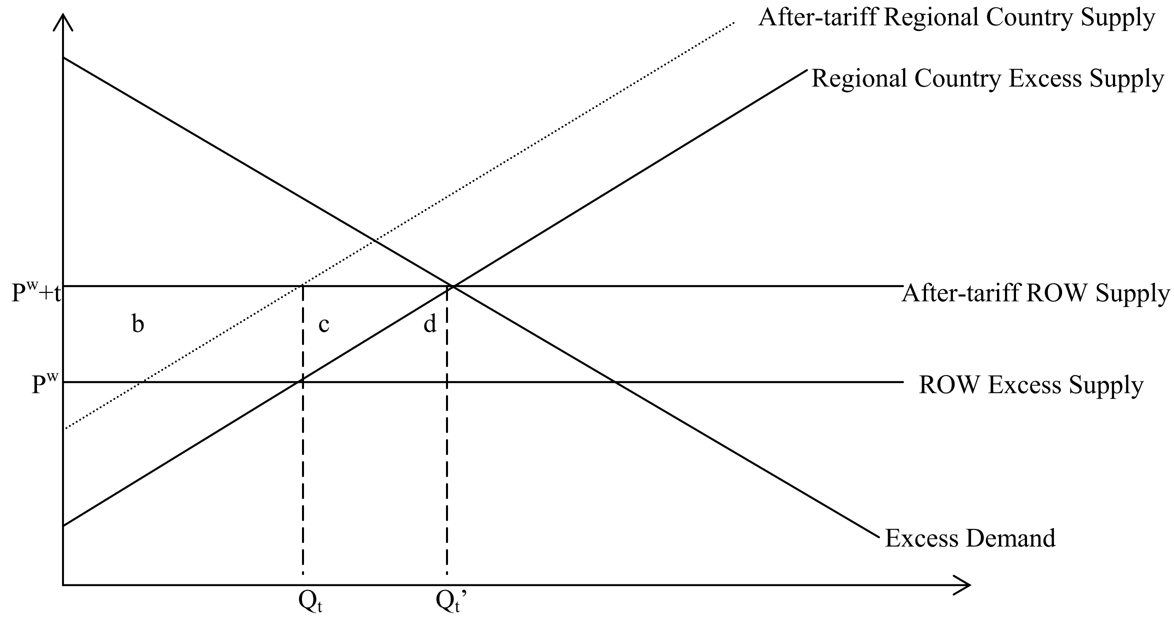


Let A be the regional importer, B the regional exporter and ROW exporters from the rest of the world. Suppose prior to the FTA, country A imports solely from the regional exporter B (note that with tariffs in place, the cost of importing from the ROW is exactly the same as the cost of importing from B). After the FTA is formed, country A can now import more from B, at a price of $P^{rc} < P^w + t$.

Country A gains b+c, but loses b+d in tariff revenues, whereas country B gains d+e, so that on net, the region gains c+e. No welfare losses/gains accrue to the rest of the world.

Trade diversion could also result: when some of the imports from the rest of the world are replaced by imports from a member of the FTA, provided the final cost of imports from the FTA member (after tariffs have been removed) is lower than the cost of importing from the rest of the world (including tariffs). Trade diversion thus results in a country shifting imports to buying from a more expensive source, that is, imports are now sourced from a less efficient producer. Therefore trade diversion constitutes a direct transfer of wealth from ROW producers to producers from the new regional exporter, as well as an indirect transfer from consumers in the importing country to producers in the regional exporting country – since consumers pay more than they would otherwise pay if the tariffs were removed on ROW imports instead. If the marginal gain to consumers in the importing county is small enough (that is, if the FTA countries are small relative to the world market), the importing country would experience a net welfare loss almost equivalent to its foregone tariff revenues. The exporting country, on the other hand, captures only part of this welfare through higher export prices and the rest of world experiences deadweight loss from lost trade. Therefore trade diversion is generally welfare reducing for both the trading bloc and the world.

FIGURE 2: TRADE DIVERSION



Let A be the regional importer, B the regional exporter and ROW exporters from the rest of the world. Suppose prior to the FTA, country A imports Q_t from the regional exporter B, and Q_t’ – Q_t from the ROW. After the FTA is formed, country A can now source all its imports more from B, at a price of $P^{rc} = P^w + t$ (note that with tariffs still in place for the ROW, the cost of importing from the ROW is now the same as the cost of importing from B).

No gains accrue to Country A, since the pre-FTA price is equal to the post-FTA price, but A loses b+c+d in tariff revenues. Country B gains only d+c of this welfare, and on net, the region loses d. Although the ROW loses the export of Q_t’ – Q_t to country B, no significant welfare loss is experienced in the ROW since both A and B are too small to influence ROW welfare. Overall, the FTA is welfare reducing.

The discussion above implies that the welfare impact of FTA is ambiguous a priori, and depends to a great deal on the extent to which trade diversion effects exceed the trade creation effects (Hoekman and Scheiff 2002). This also suggests that the structure of the industry and the nature of existing trade relations among SADC countries would influence the welfare effects of implementing region-wide tariff reforms. For example, welfare effects on net-exporters *to the SADC region* (i.e. countries that sell more cereals to the SADC region than they buy from it) are expected to differ from expected effects on net importers. For net exporters, we expect positive producer surplus responses and negative consumer surplus responses. Based on classic trade theory, we also expect the increase in producer surplus from a given price change to always exceed the consumer surplus response to an equivalent price change, so that on net, the exporter is better-off. This is because when the price in an exporting country increases, producers capture all the welfare lost by consumers in that country, as well as some of the welfare lost by producers in the importing country – true in both the trade creation and trade diversion cases. For net importers, consumers are expected to benefit, and the consumer surplus responses from a given price change to be exceed producer surplus responses, for similar reasons. The net welfare effects, however, would depend on the extent to which the net private gains exceed the loss in tariff revenues. This analysis is however complicated by the fact that although most of SADC, with the exception of South Africa, are net importers of cereals in general, at regional level, a few additional countries: Mozambique, Tanzania and Zimbabwe are net exporters to the region. For these countries, welfare responses to price changes are difficult to predict a priori.

The analysis performed in this study is compounded by the fact that some countries are already participating in free trade agreements with each other. The effects of tariff reforms for those countries already participating in one or more regional free trade agreements may differ substantially from those outlined above, as implementing region-wide tariff reforms in these countries may lead to preference erosion, hence welfare losses. These hypotheses are evaluated in the analyses performed in section 4 below. Furthermore, for specific tariff lines in some countries of the region, specifically the SACU region, protection comes in the form of tariff rates quotas (TRQs). For such commodities, tariff elimination implies that both in- and out-of-quota imports face zero tariffs, thus nullifies the effects of the quota. Noting also that SACU imports very small proportions from the SADC region (so that SADC imports almost certainly fall within the quota), and that only a small proportion of

SACU tariff lines are subject to TRQs, these are not likely to influence significantly the expected responses discussed above. These assumptions are adopted in the analysis as detailed in section 3.2.

1.3 Trade Policy in the Cereals Sector of SADC

The Southern Africa Development Community (SADC) is an economic integration block comprising of 14 countries in sub-Sahara Africa (SSA): Angola, Botswana, Democratic Republic of Congo (DRC), Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe. Through mostly unilateral policy reforms, countries of the SADC region have undergone market liberalization and trade policy changes in the past two decades, aimed at promoting market-led growth and freer trade among members. Although SADC is not a regional trading block per se, promoting intra-regional trade has become one of its core objectives, as evidenced by the ratification of the Trade Protocol in 2000, under which countries agreed to gradually phase-out tariffs in most industrial sectors by 2012. In addition, half of SADC countries are also members of autonomous free trading agreements in existence in SSA: the Southern African Customs Union (SACU) and the Common Market for Eastern and Southern Africa (COMESA), under which trade is either tariff-free (SACU), or almost tariff-free (COMESA). Despite these pro-market reforms, intra-regional trade in southern Africa remains low, accounting for about 5% of total trade, and trade restrictions are maintained in most strategic sectors, such as the food grains sectors. Regional trade in grains (especially the region's staple – maize) is subject to tariffs averaging 12%, import and export regulatory requirements, and special sanitary and phyto-sanitary (SPS) restrictions. Trade policy in this sector remains marred with unpredictability, often justified as being necessary to stabilize producer incomes and food prices (Mano et al 2003, Jayne et al 2005). Extra-regional exports are observed (23% of total exports), even as severe food shortages persist in parts of the region (SADC Food Security Network 2003, EAC 2004). Cross-hauling is also observed (24% of total regional trade), and policy coordination on pertinent issues such as production and sale of genetically modified (GM) grains is limited. South Africa and Zimbabwe are the only countries with clear legislation on production and sale of GM grain, but even for these countries, regulations differ.

Compared to the most protected cereals sectors of the world market, the level of tariff protection in the cereals sector of the SADC region, however, appears relatively low. Canada, for example applies a tariff of up to 49% on wheat imports, in addition to quantitative restrictions, and China's tariffs in the same sector are as high as 68%, again with quantitative restriction, compared to a maximum of 25% in the SADC region. Tariff rates are as high as 100% in India. Similarly, applied tariff rates for maize are as high as 438% in Korea and 124% in Mexico. Protection on rice goes up to 80% in India. However, with simple average world tariff rate for the cereals sector is around 14%, and considering that almost 38% of the world economies do not apply any tariffs on most of their cereal commodities, an average tariff rate of 12% for the SADC region is quite significant in the world market (UNCTAD TRAINS data 2004).

On a sub-regional level, distinct features of trade policy can be identified. Member of SACU: Botswana, Lesotho, Namibia, Swaziland, and South Africa, have relatively low tariffs (the same across all SACU countries) on trade with the SADC region (WITS, 2005). SACU countries currently have no safeguard or antidumping measures on cereals trade, nor do they require licenses for trade (WTO 1994 – 2006). However, special sanitary and phyto-sanitary (SPS) measures apply, and some commodities are subject to tariff quota restrictions. In South Africa, for example, tariff quota restrictions of 108 279 tons for wheat, 83 tons for rye, 110800 tons for barley, 7333 tons for oats, 269000tons for maize, and 21116 tons sorghum apply. The quotas are normally filled for all commodities, and are therefore restrictive. Out of quota tariff protection varies among sectors, for maize, for example, the tariff is based on a tariff band formula which delivers a tariff only when world prices fall below US $110/ton free-on-board US Gulf ports prices. According to this formula current tariff rates on maize are 0% (WTO 1994 – 2006). South Africa also is the only SADC country currently producing genetically modified grains for commercial sale (Mano 2003).

Malawi, Zambia and Zimbabwe – the SADC countries that are also members of COMESA – also enjoy tariff-free trade with each other for most cereal commodities, though having autonomous policies on trade with the rest of the world. These countries also have a similar state-interventionist history in their cereals production and trade policy, however with market oriented reforms implemented in the past few years, countries have adopted more liberal cereals trade policy. In Malawi tariffs on maize grain have been eliminated, though import licenses are required to engage in trade, and tariffs of up to 25% are maintained for products such as wheat flour. Although Malawi provides no export subsidies or safeguard measure, it still provides some form of domestic support to producers, and cereal imports are subject to some SPS restrictions. For example, while Malawi will accept GM grain as food aid, it prohibits planting or growing GM grains (Mano 2003). Zambia has no import license requirements for trade in cereals, though imports are subject to tariffs of up to 25% for most processed products, and numerous antidumping, rules of origin and SPS measures (WTO 1994 – 2006). The Zambian government, for example, maintains and has used the right, to ban exports during poor harvest seasons (Mano, 2003). Zambia also has a strict policy against importation of genetically modified grains, even in the form of food aid. For Zimbabwe, cereal imports are subject to relatively high tariff rates (up to 30%), and several SPS measures (WTO 1994 – 2006). Import levies are generally applied on private imports, such as the US$3.50 per 50kg bag levied on imports of maize grain, maize meal or rice in excess of one bag (FEWS NET 2005). Only the state trading enterprise – the Grain Marketing Board (GMB) – has legal authority to engage in, or provide license for, trade of grains. Although no export subsidies are offered, domestic support is given to producers in the form of subsidies inputs. Most importantly, trade policy is characterized by extreme variability and ad-hoc policy changes, mostly aimed at further restricting cross-border grain movement (Mano 2003). Like Zambia, Zimbabwe also has strict policy against importation of GM grains, although Zimbabwe has established legislature governing production of GM crops in the country, and is currently involved in GM research (WTO 1994 – 2006).

Mozambique's cereals sector, one of the least protected in the region, has tariff rates ranging between 2.5 and 7.5%, higher only for wheat and maize flour at 25% (WITS 2005, Arlindo and Tschirley 2003). Nonetheless, trade is governed by trading licenses, extensive inspections, and non-trivial taxes (World Bank DTIS, Mozambique 2004). In Tanzania, exports are generally restricted, trade can only be conducted through state-issued licenses, and an almost flat tariff rate of 25% is applied to imports of cereals and cereal products (WITS

2005, Mano et al 2003). Poor infrastructure has created localized inefficiencies in grain distribution, and foods handouts are not uncommon, however little farmer support is provided (Mano, 2003). Tanzania trades more closely with Uganda and Kenya under the East African Cooperation (EAC) – an economic integration bloc constituting these three countries. Grains, particularly maize, attract low tariffs among EAC countries, however, trade is impeded by numerous non-tariff barriers such as an unpredictable policy environment, extensive pre-shipment inspections and inconsistent SPS measures (EAC 2004). Although tariff rates are generally lower among EAC countries, the economic bloc is not a free trade area.

Angola and DRC are among the major deficit markets for cereals in the region, collectively absorbing 8% of SADC's exports, and a lot more from the world market through commercial imports and food aid (FAOSTAT, 2004). Angola applies a flat tariff rate of 2% on all grains and DRC a 5 to 10% tariff rate. Tariffs on processed cereal products are relatively higher, averaging 10% in both countries (WITS 2005). Like most SADC countries, while resistant to GM foods, these countries do not have any regulations in place to govern production and sale of GM grains (reference). Mauritius applies tariffs ranging from 0 to 20% on different tariff lines of the cereals sector.

A summary of selected descriptive statistics on the structure of the cereals sector of the SADC region between 1999 and 2002 – the study period – is presented in Table 1. Note that the 2002 tariff rates may differ from current rates, where countries have engaged in further reforms. SADC's newest addition – Madagascar – is excluded from the analysis, in accordance with the data used in the analysis discussed in Section 3.2.

Proximity seems to play a significant role in the location of each country's major trading partners, especially with regards to destination of exports, emphasizing the non-trivial effects of transport costs on trade flows. South Africa is the main source of imports from the region for all SADC countries, and countries consume most of their production as evidenced by the very high domestic absorption rates. Statistics indicate that none of the SADC countries are self-sufficient in producing all the cereals they require. This is possibly because although some countries may be self-sufficient in some of the cereals, possibly their staple (maize), most of them are not self-sufficient in the production of those cereals such as rice and wheat. For example, although South Africa has managed to produce more than its domestic requirements in maize, it produces only 45% of its wheat requirements, and imports most of its rice (FAOSTAT, 2005).

Table 1: Descriptive statistics – SADC Cereals sector, 1999-2002

	Average MFN tariff on imports[1] (%)	Average tariff on imports from SADC (%)	Average tariff on exports to ROW (%)	Major regional source of imports (% of value of Imports)	Major regional export market (% of value of Exports)	Domestic Absorption (% of value of total output)	Domestic contribution to local demand (% of value of consumption)	Membership in Regional Integration Agreements other than SADC[2]
Angola	8.5	8.5	-	South Africa (7.0)	Namibia (17.1)	99.6	65.3	
Botswana	9.0	6.0	10	South Africa (64.5)	South Africa (53.2)	26.4	1.6	SACU
DRC	8.6	8.6	-	South Africa (17.4)	Zambia (4.3)	99.6	85.0	
Lesotho	9.0	6.0	0	South Africa (94.6)	South Africa (99.1)	81.4	45.6	SACU
Malawi	16.0	6.0	25	South Africa (34.4)	Zimbabwe (52.3)	98.5	72.7	COMESA
Mauritius	2.4	2.4	-	South Africa (0.37)	Zambia (1.2)	66.4	45.6	
Mozambique	9.0	5.0	0	South Africa (12.5)	Malawi (89.7)	94.8	76.0	
Namibia	9.0	6.0	2	South Africa (55.5)	Angola (93.4)	90.3	41.2	SACU
South Africa	9.0	6.0	18	Lesotho (2.4)	Botswana (14.6)	87.7	87.0	SACU
Swaziland	9.0	6.0	0	South Africa (97.4)	South Africa (73.8)	82.6	31.0	SACU
Tanzania	25.0	25.0	1	South Africa (2.8)	Malawi (29.9)	98.1	86.0	EAC
Zambia	12.0	8.0	30	South Africa (56.8)	Zimbabwe (11.8)	98.3	86.2	COMESA
Zimbabwe	20.0	16	3	South Africa (58.5)	Botswana (48.2)	94.4	91.2	COMESA

[1] Most Favored Nation (MFN) global unit value weighted average tariff rates.
[2] Only membership to regional integration bodies entailing zero tariffs on grain trade are listed here. Note that most SADC countries are members to more regional and international preferential trading arrangements such as the Cotonou Agreement with the European Union.

2. Research Methods and Applications

2.1 Partial Equilibrium Methods

The methods for trade policy welfare analyses could be divided into two broad categories: partial and general equilibrium approaches. Partial equilibrium analyses date back to Marshall in the early 20th century, and assess the market for a single good for which the wealth effect is small (MasColell 1995). The partial equilibrium is thus viewed as a sector-specific condition, in which impacts on endogenous variables not related to the sector under study are explicitly or implicitly disregarded. The assumption is that the production/consumption decisions in the sector of interest is unaffected by changes occurring elsewhere in the economy. Thus we can combine the rest of the economy into a single composite good called the numeraire, and with an additional assumption of quasilinear utility, demand and supply can be expressed as functions of prices only, with negligible wealth effects. Comparative statics analyses would then involve direct assessment of marginal changes in quantities and prices. In practice, the relevant tax/subsidy is incorporated into the appropriate price vector of the demand and supply functions and, assuming these functions are differentiable, the marginal change in equilibrium allocation or prices is derived simply through application of the implicit function theorem. Welfare is measured through evaluation of Marshallian aggregate surplus: the utility gains from consumption less the costs of production.

Because partial equilibrium analyses posses the merit of simplicity and transparency, their application in the welfare literature has been extensive, ranging from applications of the basic model to its more sophisticated extensions such as the multi-market, multi-region global partial equilibrium models for example the USDA's Statistical World Policy Simulation (SWOPSIM) modeling framework by Roningen et al 1991, the World Bank and UNCTAD Software on Market Analysis and Restrictions on Trade (SMART) model (Stern et al 1975), the Agricultural Trade Policy Simulation Model (ATPSM) by UNCTAD and FAO 2002, and Global Simulation (GSIM) model by Francois and Hall 2003.

2.2 General Equilibrium Methods

The major limitation of partial equilibrium analyses is the risk of suppressing interactions of economic variables that may be linked in a significant way. General equilibrium analyses differ from the former in that they view the economy as an interrelated system in which the equilibrium values of all variables of interest must be simultaneously determined. The basic theoretic structure for general equilibrium analysis was developed by Walras in the late 1800's, and improved upon by Debreu 1959, Johansen 1960, Harberger 1962, Scarf 1967, Arrow and Hahn 1971, among others. Some of the early applications and major contributions to the theory of general equilibrium welfare analyses were through the work of Heckscher, Ohlin, Leontief, Samuelson, Stolper and Rybczynski in the mid 1900's. The basic general equilibrium model is a static two-factor model, from which two or more commodities are produced, with the assumptions of constant returns to scale technology, and homothetic preferences. In a Walrasian equilibrium, factor and goods markets must simultaneously clear, and utility and profits maximized. Although neither existence nor uniqueness of the general equilibrium is guaranteed, to the extent that consumer preferences and production technologies are well-behaved, these can be assumed with a significant degree of certainty. Comparative statics are normally performed by way of the Kuhn-Tucker estimations, assuming differentiable production and utility functions, and welfare is normally measured using the Hicksian equivalent variation and compensation variation.

The theoretic framework described above has been applied to empirical situations to test the effects of trade policy through applied general equilibrium models. Most applications of the general equilibrium framework are based on the Heckscher-Ohlin model, with the assumption of national product differentiation, also known as the Armington assumption. Early applications of general equilibrium modeling include Dixon et al 1982's work using the ORANI short run CGE model to analyze protection in the Australian economy, Dervis et al 1982 analyzing protection policies in developing countries, and Whalley 1985 in multi-regional trade policy analysis. Some recent applications include the price or quantity based distance function measures of trade restrictiveness (Anderson and Neary 1996, Chau et al 2003); and the expenditure and utility function based approaches such as the Social Account Matrix (SAM) based Computable General Equilibrium (CGE) models (DeMelo 1988, Robinson et al 1988, Deverajan and Rodrik 1991, Lewis et al 2003), as well as global CGE models such as the Global Trade Analysis Project (GTAP) by Hertel 1997 and the US Applied General Equilibrium model by the International Trade Commission (USAGE-ITC) (USITC 2004).

In addition to capturing inter-sectoral linkages, general equilibrium models have several advantages over partial equilibrium models, especially in analyzing agricultural trade policy. First, evaluation is focused to household level, where the assumption of a representative household – owner of factors of production, consumer, taxpayer and recipient of subsides – is often made. This specification allows for the evaluation of macro policies' impacts at the most disaggregated level (Hertel 1999). Second, applied models provide a setting for evaluating welfare effects in a second-best environment – where public intervention spans several levels of a given industry – by taking into account existing policy distortions in welfare evaluations, which makes them especially suitable for evaluating agricultural policy reforms. Third, most applied general equilibrium models are based on detailed accounting identities that must hold for an economy to be in equilibrium. This restriction is important for ensuring national or global market clearing, and preventing policy simulation outcomes in which economies spend more than their finites resources can support. Finally, general equilibrium models provide economy-wide assessments that emphasize relative, as opposed to absolute, efficiency and welfare difference – in accordance with the theory of comparative advantage. General equilibrium models, however, also tend to be data intensive, and may involve complex forms of analyses and huge resource investments. The construction of SAMs, for example, tends to be a lengthy process requiring in-depth access to data sources. At times, only marginal gains in precision are gained from these investments (Devarajan et al 1997). CGE models also are based on a number of restrictive assumptions, requiring a set of equilibrating conditions such as zero excess demands through market clearing conditions and full employment of resources. Such assumptions may not always be appropriate for developing countries (de Melo 1988).

2.3 Model Specifications

The main differences between theoretic and applied models are that the former is based on the premise of perfect competition, where the economy is initially assumed to be in an undistorted equilibrium, and infinitesimal tariffs are then introduced to compute new equilibrium outcomes, the so called first best welfare evaluation. Such neoclassical models generally assume homogenous goods, produced and traded according to comparative advantages. Applied models, also know as second best evaluations, generally take into account the distortions that already exist in a given economy due to policy. As a result, it is not always the case that trade liberalization improves welfare, as trade reform could indeed lead to resource re-allocation from one distorted sector to an even more distorted one (Francois and Reinert, 1997). Evaluations are usually based on trade policy changes that are actually under consideration, not just hypothetical ones.

An important aspect in model specification in applied trade policy analysis is the degree of substitutability of domestic commodities for imports. Perfect substitute models make the assumption that domestic goods and imports are homogenous, and can be substituted one for one. The elasticity of substitution is normally assumed constant (the case of constant elasticity of substitution, or CES utility function), and for perfect substitutes, this elasticity is infinity. Most commodities however have been found to not be as homogenous across borders, and the assumption of imperfect substitutes, also known as the Armington assumption, has been made where goods of the same kind are distinguished by their country of origin. Armington models incorporate competing products by evaluating horizontal linkages for similar but not identical products. The models also generally assumes well behaved preferences, by assuming constant elasticity of substitution between products competing in any market and the same elasticity of substitution between any two products, i.e. elasticities do not depend on the market share and are the same between any pair of products competing in the same market. The demand functions for each of mn goods – for n kinds of goods from m countries – are given by an nxm matrix X. To capture the close link between goods of the same kind, the assumption of 'independence' is made for the utility function, so that the marginal rate of substitution between any two products of the same kind is independent of the quantity of the products of all other kinds. Moreover, the utility functional form must be such that the quantity index for each kind of commodity *i,* given by $X_i = \varphi_i(X_{i1}, X_{i2}, \ldots, X_{im})$, is linear and homogenous. This implies that market shares (the share of any given product in the market) depend only on the relative prices of the products in the market, and not on the size of the market. Therefore there exists an unambiguous demand for any subset of products in the i^{th} market. These properties result from assuming separability of demands for each product, and homothetic preferences, normally represented by a CES utility function. It has been shown in the literature that mis-specification of elasticities can lead to significant error in calculating welfare effects, therefore sensitivity analyses with alternative levels of elasticities are often performed. The literature also indicates significant differences between lower-tier versus upper-tier estimates of elasticities, long run versus short run estimates, cross-sectional versus time series estimates, and the level of commodity aggregation.

Welfare analyses can be performed in a static or dynamic context, to capture the response at a given point in time in the former case, and the changes over time in the latter case. Static evaluations generally make use of comparative statics, using either Hicksian or Slutsky decomposition of substitution and income effects. Through a hypothetical change in income, one can achieve the original utility level with Hicksian decomposition, or the original optimum bundle of goods with Slutsky decomposition. In empirical analyses the use is Slutsky decomposition tends to be preferable, since only price and quantity data is required, whereas with Hicksian one would need to estimate the utility function. Dynamic modeling also can be achieved through the use of comparative statics with time subscripts, where a series of single-period equilibria are linked through static decisions that change household income or the capital stock of the economy through time, or through the use of dynamic optimization procedures.

Applied general equilibrium models are commonly used to assess the economic effects of trade policy, a process that generally requires conversion of policy changes into price effects, to estimate how policy is expected to affect incomes, quantities produced / consumed, employment trade flows and macro-economic welfare. The common procedures of estimating numerical welfare measures of gain or losses due to policy changes are through evaluation of Marshallian aggregate surplus or Hicksian compensation and equivalent variation. Marshallian aggregate surplus measure the changes in producer and consumer surplus from the Marshallian demand function *x(p,w)* and the supply function *q(p)*, where *x* is demand as a function of prices, *p*, and wealth, *w*, and *q* is supply as a function of price. The assumption is that the good under analysis is one of many, so that on the consumption side, it constitutes a small portion of the overall budget. In addition we assume that the changes in the market for this good will have negligible effects on the prices of other goods. Alternatively, the Equivalent Variation (EV) and Compensating Variation (CV) procedures, due to Hick 1939, can be used to evaluate consumer welfare resulting from a policy that directly (or indirectly) affects prices or utility. In this case, welfare is measured in monetary terms through the estimation of money metric indirect utility functions. Taking p^0 to represent initial prices before policy change, u^0 initial indirect utility level, and $e(p^0,u^0)$ as initial consumer expenditure, CV is defined as: CV = $e(p^1,u^1) - e(p^1,u^0)$ and EV as: EV = $e(p^0,u^1) - e(p^0,u^0)$. Welfare improvements are observed when the CV is negative, or when EV is positive. In comparison to Marshallian consumer surplus, the relationship CV ≤ CS ≤ EV generally holds, with equalities for special utility forms such as quasilinear utility functions (MasCollel et al 1994). Some basic partial and general equilibrium applied methods of trade policy analysis are briefly reviewed in Appendix 1.

3. Model and Data

3.1 The Global Simulation Model

The liberalization of trade in cereals in the SADC region is expected to have significant effects on production and trade trends in the regions, given their significant contribution to both consumption and farm income. Of particular interest to policy makers are the potential food security effects at national and household levels. In this study, a regional level partial equilibrium analysis is performed, to estimate the potential effects of tariff reforms on domestic prices, consumer and producer surplus, and government revenue for each of the thirteen countries in the SADC region. The global simulation model (GSIM), due to Francois and Hall (2003), is used for this analysis. This static, partial equilibrium model allows for multi-country modeling, to capture welfare effects of policies implemented at regional and global levels. The partial equilibrium nature implies that analyses can be as focused as tariff-line level (the source of tariff changes), and by aggregating trade for all countries in which no policy changes are expected, the analysis can be focused only on those countries of interest. The model is detailed, utilizing comprehensive bilateral trade and tariff data at highly disaggregated levels, as well as data such as exports, domestic production and domestic absorption (captured as trade with self). The inclusion of export statistics adds the requirement of export market clearing to the market clearing conditions, improving precision of results through consolidation of import and export trade flows. It also enables the analysis of export market access policies. The inclusion of domestic production and absorption allows for the prediction of self-sufficiency effects, a critical policy issue in food markets. This framework also offers extensive analytical capacity compared to conventional partial equilibrium tools, providing for the analysis of simultaneous policy changes in domestic production, taxes or subsidies; export subsidies; and tariff rates. Compared to global general equilibrium models, the GSIM model is more flexible, allowing for disaggregated sector specific analysis while capable of maintaining global scope – CGE models typically provide estimates at aggregate level. GSIM also offers transparency, so that welfare evaluation, measured in explicit income terms, can be disaggregated to producer, consumer and state level; and sources of economic adjustments can be clearly identified (Francois and Hall 2003).

Though still fairly new, GSIM has already been applied in several welfare studies (Vanzetti 2004, Luo et al 2004, Holzner 2004). Results from the GSIM framework can also be obtained directly from the World Bank's trade database: the World Integrated Trade System (WITS), along with SMART results. To ensure close inspection and validation of trade, production, and absorption statistics, as well as tariff rates and elasticities, this study employs the basic theoretic version of the model, analyzed using Excel Solver, to find the global market clearing prices. The GSIM model is based upon the assumption of national product differentiation. The Armington assumption recognizes that commodities may not be homogenous across borders, implying that imports are imperfect substitutes of each other. In accordance with Armington 1969, we adopt the constant elasticity of substitution assumption for products competing in any market, so that elasticities are independent of market share and are the same between any pair of products competing in the same market. Assuming weak separability of demand and homothetic preferences represented by a constant elasticity of substitution (CES) utility function, we obtain an unambiguous demand for any subset of products in each market. Both the elasticity of aggregate demand and elasticity of export supply are held constant. The import demand and export supply take on the log-linear form.

Following Francois and Hall 2003, we can define an import demand function characterizing the import of each of the 12 'varieties' of cereals into any given market of the region:

(1) $M_{(i,v),r} = f(P_{(i,v),r}\ ,\ P_{(i,v),s\neq r}\ ,\ y_{(i,v)})$

where $M_{(i,v),r}$ is the quantity of good *i* imported from region *r* in country *v,* $P_{(i,v),r}$ is its price and $y_{(i,v)}$ total expenditure on good *i* in country *v*. $P_{(i,v),s\neq r}$ are the prices in *v* of varieties of *i* from regions other than *r*. The benchmark prices are restricted to equal 1, so that in the benchmark equilibrium, the quantity and the value of imports is the same. Total supply of exports from region *r* is given as a function of $P^{w}_{i,r}$ – the world price of *i* originating from region *r*:

(2) $X_{i,r} = f(P^{w}_{i,r})$

The income and substitution effects on M(.) resulting from price changes in one or more varieties of *i* can be expressed in elasticity form as:

(3) $N_{(i,v),(r,s)} = \theta_{(i,v),s}\ (E_m + E_s)$

(4) $N_{(i,v)(r,r)} = \theta_{(i,v),r}\ E_m - (1 - \theta_{(i,v),r})E_s$

where $N_{(i,v),(r,s)}$ is the cross price elasticity and $N_{(i,v)(r,r)}$ is the own price elasticity, $\theta_{(i,v),s}$ is the expenditure share of imports of *i* from *s* in region *v*, E_m is the composite demand elasticity in importing region *v*, and E_s is the elasticity of substitution. Region *s* can be domestic, representing trade with self. The internal price of good *i* is a function of the prevailing import taxes, and the world price for *i*:

(5) $P_{(i,v),r} = (1+ t_{(i,v),r}\ )\ P^{w}_{i,r} = T_{(i,v),r}\ P^{w}_{i,r}$ *and* $P_{(i,v)} = \sum_r (\theta_{(i,v),r}\ .\ P_{(i,v),r}\ )$

where $P_{(i,v)}$ is the composite consumer price of *i* in region *v*, $t_{(i,v),r}$ is the ad valorem tariff rate applied on imports of good *i* from region *r* at point of entry into country *v*, and $T_{(i,v),r} = (1+ t_{(i,v),r})$. Using proportional changes we can express the percentage changes in exports, imports and internal prices as functions of world prices, elasticities and tariff rates:

(6) $\Delta P_{(i,v),r} / P_{(i,v),r} = \Delta P^{w}_{i,r} / P^{w}_{i,r} + \Delta T_{(i,v),r} / T_{(i,v),r}$

(7) $\Delta X_{i,r} / X_{i,r} = E_{X(i,r)}(\Delta P^{w}_{i,r} / P^{w}_{i,r})$

(8) $\Delta M_{(i,v),r}/M_{(i,v),r} = N_{(i,v),(r,r)}(\Delta P_{(i,v),r}/P_{(i,v),r}) + \sum_{s\neq r}N_{(i,v),(r,s)}(\Delta P_{(i,v),s}/P_{(i,v),s})$

E_X is the elasticity of aggregate export supply. The market clearing conditions are then given by:

(9) $\Delta M_{i,r} / M_{i,r} = \Delta X_{i,r}/X_{i,r}$, *where* $M_{i,r}=\sum_v M_{(i,v),r}$

Assuming locally linear demand and supply functions[3], welfare effects are assessed by evaluating the changes in producer and consumer surplus:

(10) $\Delta PS_{(i,r)} = X^{0}_{(i,r)}\Delta P^{w}_{i,r} + ½\Delta P^{w}_{i,r} . \Delta X_{i,r}$

(11) $\Delta CS_{(i,v)} = \sum_r(R^{0}_{(i,v),r}\ T^{0}_{(i,v),r}).(½E_{m,(i,v)}(\Delta P_{(i,v)}/ P_{(i,v)})^{2} - (\Delta P_{(i,v)}/ P_{(i,v)}))$

where $R^{0}_{i,r} = P^{w}_{i,r} . X^{0}_{i,r}$ is the benchmark export revenue valued at world prices, $T^{0}_{(i,v),r}$ is the initial tariff level on imports of good *i* from region *r* into country *v*, and $R^{0}_{(i,r)}\ T^{0}_{(i,v),r}$ initial expenditure at internal prices. The changes in government revenue are given by:

(12) $\Delta GR_{(i,v)} = (\sum_r R^{1}_{(i,v)r} .T^{1}_{(i,v),r} - \sum_r R^{1}_{(i,v),r}) - (\sum_r R^{0}_{(i,v)r} .T^{0}_{(i,v),r} - \sum_r R^{0}_{(i,v),r})$

In the model specification assuming fixed world prices, when each *r* is a *small* country, the own and cross trade effects of tariff reforms are obtained directly from a decomposition of the aggregate imports function represented in (9) above:

(13) Own Trade Effect = $M_{(i,v),r} . N_{(i,v),(r,r)} . (\Delta T_{(i,v),r} / T_{(i,v),r})$

(14) Cross Trade Effect = $M_{(i,v),r} . \sum_{s\neq r} [N_{(i,v),(r,s)}(\Delta T_{(i,v),s} / T_{(i,v),s})]$

A few limitations of the GSIM model are noted. First, a partial equilibrium model, GSIM fails to capture inter-sectoral linkages and therefore, may suppress some significant economic interactions. Consequently, gains/losses from policy reforms tend to be overestimated, as resource re-allocation among sectors is not taken into account. Second, like most applied global models, GSIM is based on the representative agent assumption. However, in a region where diversity exists among different producer and consumer groups, in terms of responsiveness to changes in income or prices, representative welfare effects may differ non-trivially from

[3] Approximate values, since import demand is defined as a log-linear function, not a linear function as such.

individual household effects. Estimated welfare responses are also based on the assumption that price transmissions are complete, and to the extent that changes in border parity prices are only partially transmitted to the household and producer levels, actual responses to reforms may be less severe. Despite these limitations, the GSIM model is chosen as the main method of analysis in this study because it enables decomposition and quantification of welfare effects into monetary terms for different household groups – the study's main objective, whereas general equilibrium models tend to give aggregate welfare effects. The results from the GSIM model are later validated through several sensitivity analyses, one of them a general equilibrium assessment of the policy changes[4], as discussed a greater detail in Section 5.

3.2 Data Requirements

The data required for this analysis include (1) bilateral trade volumes by source and destination, (2) domestic production and absorption, (3) tariff rates, and (4) elasticities of composite demand, supply and substitution. Data were obtained from the World Integrated Trade Solution (WITS) database, SADC Secretariat, GTAP Database, US International Trade Commission (USITC), Food and Agriculture Organization (FAO) database FAOSTAT, the Trade Analysis Information System (TRAINS), the WTO's internal documents and national statistics offices: Central Statistics Offices (CSO) of Botswana, Zambia and Zimbabwe, National Statistical Office (NSO) of Malawi, and South Africa's Grain Information Service (SAGIS) and the Department of Trade and Industry (DTI). Table 2 presents a detailed outline of the data sources.

Comprehensive bilateral trade data were available from WITS for 11 of the 13 SADC countries included in the study for a period of 4 years from 1999 to 2002. Statistics for Angola and DRC were deduced from inverse sides of these statistics, and from the aggregate trade statistics available in FAOSTAT. These two countries generally have very limited data records for their cereals sectors, and though sizeable recipients of imports from SADC (about 6%), are not major supplier on the regional market (collectively accounting for 0.07 % of total

[4] The cereals sector is a fairly small contributor to GDP for most of SADC, contributing between 4 and 17% of GDP, and may be reasonably expected to have limited backward and forward linkage effects.

value of regional trade). As a result these two countries, together with Mauritius, are aggregated into a regional category called 'other SADC' countries (Mauritius is included into this category more due to its very limited interaction with the SADC region in the trade of cereals, rather than for data reasons). The sector 'cereals' is defined as all grains and processed products of maize, wheat, rice, sorghum, millet, and other small grains[5] as they appear in Chapters 10 and 11 of the 2002 Harmonized Commodity Description and Coding System.

Table 2: Data and Sources

	Bilateral Trade Volume	Domestic Production and Absorption	Tariff Rates	Elasticities of export supply, composite demand and substitution
Angola	WTO (imports)	FAOSTAT	TRAINS, SADC	- , USITC
Botswana	WITS, CSO	FAOSTAT, CSO	WITS, SADC	WITS, GTAP, USITC
DRC	WTO (imports)	FAOSTAT	TRAINS, SADC	- , USITC
Lesotho	WITS	FAOSTAT	WITS, SADC	WITS, GTAP, USITC
Malawi	WITS, NSO	FAOSTAT, NSO	WITS, SADC	WITS, GTAP, USITC
Mauritius	WITS	FAOSTAT	WITS, SADC	WITS, USITC
Mozambique	WITS	FAOSTAT	WITS, SADC	WITS, GTAP, USITC
Namibia	WITS	FAOSTAT	WITS, SADC	WITS, USITC
South Africa	WITS, DTI	FAOSTAT, SAGIS	WITS, SADC	WITS, GTAP, USITC
Swaziland	WITS	FAOSTAT	WITS, SADC	WITS, USITC
Tanzania	WITS	FAOSTAT	WITS, SADC	WITS, GTAP, USITC
Zambia	WITS, CSO	FAOSTAT, CSO	WITS, SADC	WITS, GTAP, USITC
Zimbabwe	WITS, CSO	FAOSTAT, CSO	WITS, SADC	WITS, GTAP, USITC

The following computations were performed to obtain the comprehensive dataset used for analysis:

- Using WITS elasticities of demand and import volumes at tariff line level, sector elasticities of demand were computed by the import weighted average method:

  $E_m = \sum_i (\theta_i . E_i)$, where E_i is the tariff-line specific elasticity of demand for product *i*, and θ_i is the proportion of imports accounted for by product *i*. E_m is the elasticity of 'composite demand', and ranges from -0.55 to -1.01 for the countries in the region.

- Specific duties (applied to some products entering SACU markets e.g. R0.19/kg for HS 100190 – wheat and meslin) are converted to their ad valorem equivalents (AVE) using the WTO formula:

  AVE = [(Specific Duty x Quantity Imported)/Value of Imports at world prices] x 100

  Currency units are first converted accordingly to their US$ equivalents.

[5] Includes rye, barley, oats, buckwheat, and canary seed. These collectively account for only 0.12% total value of trade.

- Three different sources were referred to for data on tariff rates, and in most cases the tariff rates recorded in each source differed, so that the SADC most favored nation rates > WITS rates > GTAP rates. Tariff rates were consolidated using the simple average method, and sensitivity analyses with rates from each source performed as detailed in section 5.
- Tariff rates were aggregated across tariff lines using the global unit value weighted sum method to avoid the problem of endogeneity associated with import weighted averages, and the upward bias associated with taking simple averages. The global unit value is defined as global value of trade at tariff line level ÷ total quantities traded. Generally three different aggregation procedures can be used: import weighted sum, global unit value weighted sum, and the simple average (Laird, 1997). The major limitation of the import weighted average is that it tends to be biased downward since higher tariff rates are naturally associated with lower trade volumes; whereas the simple average estimates tend to overstate the level protection where higher tariff rates are applied on products that would not be traded in large volumes anyway.
- To compute the tariffs faced by SADC countries when they export to the rest of the world, an export weighted average was used, by consulting the export destinations' tariff schedules.
- For specific tariff lines in some countries of the region, protection comes in the form of tariff rates quotas (TRQs), for example the tariff of 20% plus 29.4c per kilogram of exports above the quota level of 108 279 tons for SACU imports of wheat and meslin flour (HS 110100). By making the assumption that imports from SADC always fall within the quota limits, the analysis of the effects of tariff reforms on these product lines simplifies to an analysis of the effects of reforming the in-quota tariff rates. This assumption makes sense because the SADC region in total does not currently export enough to SACU to cover the relevant quota levels.
- Domestic absorption is defined as the proportion of domestic output that is consumed locally, computed as:

  Absorption = Production Value at World Prices – (Exports Value – Re-exports Value)

- The analysis employed a symmetric supply elasticity of 0.8 adopted from Jayne et al 1994 and 1995, and an elasticity of substitution of -5 adopted from the USITC 2004. Considering the usual sensitivity of results to choice of parameters such as elasticities, robustness test were performed in Section 5, using varying elasticities of substitution and supply[6]. From these analyses, lower and upper bounds of expected welfare changes can be determined.

3.3 Simulations

The following simulations were performed:

1. Complete intra-regional tariff reforms, with the assumption that the SADC tariffs applied to imports from the rest of the world (ROW), and the level of tariff protection in the ROW, are maintained at current rates. This simulation assesses the potential impacts of tariff reforms in the cereals sector according to the SADC Trade protocol.
2. Complete tariff reforms on imports from the region and from the world i.e. setting the most favored nation (MFN) tariff rate at zero (to compare welfare effects of intra-regional to global tariff reforms).
3. Complete intra-regional tariff reforms, in only some of the regional countries, with current protection levels on imports from the ROW. The goal is to evaluate the effects of defecting in some countries of the SADC region, to assess incentives for free-riding.

To shed more light into the potential impacts on food security, specifically, exposure to external supply shock, the following simulations will also be performed:

4. Response to a supply shock in a single country (one of the SADC countries) first in the absence of liberalization, then with liberalization.
5. Response to a supply shock from the rest of the world first in the absence of regional liberalization, then with liberalization.

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[6] Estimates for elasticities form the literature differ significantly depending on product aggregation and geographic restrictions (Gibson 2003, McDonald et al 1999, Weber et al 1988,)

4. Results

4.1 Simulations 1 and 2: Elimination of intra-regional and MFN tariffs

Results from the first 2 simulations are presented in table 3, with the parenthesized values representing results from the second simulation – indiscriminate elimination of tariffs on imports into SADC. The column 'net private welfare effects' represents the expected sum of producer and consumer surplus changes intended to measure if the economic gains from a price change more than compensate for the expected losses at household level. This analysis evaluates the belief that increased intra-regional trade, through facilitating better grain movement, will benefit both importers and exporters of food, at least on a household/farm level. As noted in section 1.3, proponents of freer trade in the region normally do not place much value on tariff revenues generated from protectionist policies. Results indicate that indeed, the tariff revenues generated from the cereals sector account for a small proportion of tariff revenues – generally less than 0.5%. From the hypotheses presented in Section 1.2, if trade creation occurs, we expect trade with the SADC region to increase without reducing trade with the ROW. Trade diversion occurs when an increase in trade with SADC is achieved at the expense of trade with the world.

Table 3a: Intra-regional vs MFN Tariff Elimination, Price and Trade Effects

	Overall Consumer Price % Δ	Producer Price for Home Goods % Δ	Output % Δ	Domestic Absorption % Δ	Imports from SADC $ value % Δ	Imports from ROW $ value % Δ	Exports to SADC $ value % Δ	Exports to ROW $ value % Δ	Aggregate Supply % Δ
Botswana	-2.14 (-3.95)	-0.53 (-1.94)	-0.42 (-1.6)	-6.1 (-6.5)	3.2 (1.4)	-8.7 (24.6)	20.3 (14.6)	5.2 (19.9)	1.9 (3.6)
Lesotho	0.16 (-1.08)	0.15 (-0.85)	0.12 (-0.7)	-0.1 (-0.4)	-0.3 (-0.3)	1.4 (36.2)	1.13 (-3.5)	-2.6 (9.0)	-0.1 (0.8)
Malawi	-1.00 (-1.77)	-0.69 (-1.25)	-0.56 (-1.0)	-0.6 (-1.0)	20.3 (23.4)	-4.1 (20.7)	20.7 (8.3)	7.2 (13.0)	0.9 (1.6)
Mozambique	0.24 (-1.94)	0.35 (-1.19)	0.28 (-1.0)	-0.7 (-2.2)	17.5 (14.6)	0.3 (15.4)	24.2 (25.8)	-2.2 (12.4)	-0.2 (1.5)
Namibia	0.53 (-3.36)	1.00 (-2.04)	0.80 (-1.6)	-2.8 (-3.7)	0.5 (-10.4)	2.5 (26.2)	39.1 (16.7)	-10.4 (20.9)	-0.5 (2.9)
South Africa	0.50 (-1.78)	0.57 (-0.92)	0.46 (-0.7)	-0.9 (-2.5)	7.1 (2.6)	2.0 (33.7)	16.5 (12.6)	-5.8 (9.8)	-0.5 (1.8)
Swaziland	0.39 (-1.01)	0.35 (-0.74)	0.28 (-0.6)	-0.1 (-0.5)	-0.1 (-0.1)	1.9 (36.6)	2.6 (-1.9)	-3.8 (8.0)	-0.3 (0.8)
Tanzania	-0.11 (-7.09)	-0.02 (-4.93)	-0.01 (-3.9)	-0.4 (-4.9)	98.8 (72.8)	-0.4 (70.1)	31.1 (37.5)	0.2 (49.8)	0.1 (5.9)
Zambia	-1.72 (-2.76)	-1.27 (-2.05)	-1.01 (-1.6)	-1.3 (-2.0)	20.0 (21.0)	-7.6 (24.4)	19.7 (13.4)	12.7 (21.0)	0.9 (1.5)
Zimbabwe	-1.58 (-3.30)	-0.96 (-2.28)	-0.77 (-1.8)	-2.2 (-3.3)	57.2 (53.6)	-7.0 (53.9)	23.1 (20.0)	9.6 (23.3)	0.9 (1.9)
other SADC	-0.42 (-8.59)	-0.28 (-5.79)	-0.23 (-4.6)	-0.3 (-5.5)	42.4 (-4.9)	-1.7 (19.0)	32.6 (42.6)	2.8 (58.5)	0.4 (7.7)

Table 3b: Intra-regional vs MFN Tariff Elimination, Welfare Effects

	Producer Surplus Change US$'000	Consumer Surplus Change US$'000	Tariff Revenue Change US$'000	Net Welfare Effect US$'000	Net *private* welfare effects US$'000	Net Welfare as % of total value of cereals trade	Tariff Revenues Δ as % of total government revenues
Botswana	-85 (-311)	1884 (3503)	-1901 (-2296)	-102 (895)	1799 (3192)	-0.12 (1.06)	-0.085 (-0.10)
Lesotho	87 (-490)	-142 (968)	-125 (-186)	-181 (291)	-55 (478)	-0.20 (0.33)	-0.013 (-0.02)
Malawi	-3640 (-6528)	5858 (10396)	-2321 (-3093)	-103 (774)	2218 (3868)	-0.02 (0.13)	-0.67 (-0.89)
Mozambique	1088 (-3731)	-923 (7436)	-201 (-3703)	-37 (0.9)	165 (3705)	-0.01 (0.0002)	-0.04 (-0.67)
Namibia	242 (-488)	-275 (1756)	97 (-1141)	-33 (126)	-33 (1268)	-0.01 (0.25)	0.005 (-0.05)
South Africa	15807 (-25270)	-13823 (49778)	380 (-26917)	2364 (-2410)	1984 (24508)	0.09 (-0.09)	0.0007 (-0.05)
Swaziland	66 (-140)	-183 (476)	-38 (-71)	-155 (263)	-117 (336)	-0.33 (0.56)	-0.001 (-0.002)
Tanzania	-123 (-36584)	929 (63315)	-926 (-24914)	-120 (1816)	806 (26731)	-0.01 (0.22)	-0.06 (-1.58)
Zambia	-4200 (-6785)	6555 (10563)	-2497 (-3173)	-142 (604)	2355 (3778)	-0.04 (0.16)	-0.57 (-0.73)
Zimbabwe	-7232 (-17068)	12468 (26119)	-3992 (-9255)	-756 (-205)	5236 (9051)	-0.10 (-0.03)	-0.59 -(1.36)
other SADC	-1024 (-20517)	3555 (74768)	-3494 (-51281)	-963 (2969)	2531 (54251)	-0.12 (0.37)	-

Effects of Intra-regional and (MFN) tariff elimination.

Overall, results from the first simulation indicate that on net, elimination of intra-regional tariffs is welfare reducing for the region (a robust result, as indicated by the sensitivity tests performed in section 5). Net *private* welfare gains are however positive as expected for most of the region (with the exception of Lesotho, Swaziland and Namibia), an indication that at the household and farm levels, the expected gains from intra-regional tariff reform exceed the expected losses. Unilateral elimination of MFN tariffs on all imports, on the other hand, is welfare improving. In fact, positive net welfare gains are also expected if only external tariffs are eliminated, maintaining current tariffs on imports from the region. We note here two important issue: first that the tariff revenues derived from the cereals sectors contribute meagerly (less than 1%) to overall government revenues for each of the countries in the region, and that the net welfare losses observed are very small relative to the total value of trade (generally less than 0.5% in the first simulation) and to the GDPs (the cereals sector contributing between 4 and 17% of GDP). At a sub-regional and country-level, results follow an interesting pattern, discussed in the following sections under a categorization of the SADC countries into (1) COMESA countries, (2) SACU countries, and (3) Mozambique and Tanzania.

COMESA Countries:

COMESA countries (Malawi, Zambia, Zimbabwe) are expected to experience a decrease in producer prices, as broader SADC tariff reforms encourage greater import response, and aggregate supply (output + imports – exports) increases in each market. Domestic absorption and imports from each other generally drops (a result of preference erosion) as trade with other countries in the SADC region increases. Imports from the ROW also decrease substantially for each of these countries, whereas exports to the ROW are expected to increase[7]. The lower consumer prices imply gains in consumer surplus that outweigh the losses in producer surplus in all four countries, an expected result for net importers from the region. Zimbabwe is a net exporter to the SADC region, but since the expected drop in producer prices is almost twice the expected drop in consumer prices, we also get an increase in (producer + consumer) surplus, indicating net private gains. The group classified as 'other SADC countries' follows comparable trends, though at a smaller magnitude of price changes. Botswana also follows similar trends, differing from other SACU countries, mainly because of relatively high trade with non-SACU SADC countries, and lower prices in these markets lead to more imports (Zimbabwe, for example, supplies 30% of Botswana's cereals needs). Botswana's imports from Zimbabwe are expected to increase by up to 35% (higher imports from Tanzania and Zambia are also expected) as trade with SACU countries decreases (a drop of up to 13%, for example, is expected in the trade between Botswana and South Africa).

SACU Countries:

For the rest of SACU, prices are expected to increase, as the increase in exports from the SACU region (specifically South Africa) to the rest of SADC, outweighs the expected rise in both domestic output and imports from the region, so that aggregate supply is expected to fall. For Swaziland, Namibia and Lesotho, net importers from South Africa, SADC-wide tariff reforms lead to a loss of preference as South Africa's export destinations, and the expected lower consumer prices from SADC tariff elimination are not realized. Instead, the drop in imports from South Africa, among other responses, leads to a fall in aggregate supply of cereals in these countries. As expected for net-importer countries, the losses in consumer surplus outweigh the expected gains in

[7] An unusual result, considering that the level of protection in the ROW remains unchanged.

producer surplus from higher domestic prices, and both net welfare and net private welfare gains are negative. For South Africa, a net-exporter, the increase in producer surplus exceeds the loss in consumer surplus and the change in net private welfare is positive.

South Africa is the only SADC country experiencing positive net welfare gains from increased intra-regional trade, mainly because for this country – a meager[8] importer from the SADC region – removal of SADC tariffs comes at very small revenue costs. In fact, tariff revenues are expected to increase, as ROW exports to South Africa increase in response to the higher domestic prices. Considering that South Africa, like the other coastal countries of the region, imports almost exclusively from the ROW, the tariff revenue effects of this increase more than compensate for the expected revenue losses on trade with the region. It seems that the expected trade diversion from a reform of SADC tariffs (South Africa replacing its ROW imports with SADC imports) is very minimal in this case, possibly because South Africa imports from the world market at fairly low shipping costs, so that the price decreases within the region would have to be substantial for significant trade diversion to occur. Exports from South Africa to the ROW however are expected to drop, as the tariff level in the SADC region decreases. Other SACU countries, with the exception of Botswana, also record increasing imports from (and lower exports to) the ROW, although for these countries, trade with South Africa seems to remain dominant.

Notably, on a sub-FTA level, the general price trends differ between countries in the SACU free trade region and those in COMESA. In the SACU case when preferential access is extended to the greater SADC region, it is still profitable for SACU countries to continue importing from South Africa, whereas for COMESA, SADC-wide tariff reforms reveal more profitable import sources and countries switch. As a result SACU importers do not benefit from improved access to other SADC markets, as they already imported (and continue to import) at zero tariffs from South Africa. On the other hand, COMESA consumers benefit from greater market access.

[8] SADC contributes less than 3% of South Africa's imports of cereals, in value terms.

Mozambique and Tanzania:

For Mozambique, smaller price and welfare effects are expected from intra-SADC tariff reforms, not surprising given the already low tariff rates (average about 5% for the sector). Mozambique also imports only 4% of domestic needs from SADC, and over 20% from the rest of the world (specifically, Asia and the United States), and exports a similar proportion of local production (mainly to Malawi). Thus, SADC-wide elimination of tariffs, though increasing Mozambique's trade with the region, does not generate major responses on the domestic market. Tanzania is only different in that its tariff rates are the highest in the region (average about 25% for the sector). However, Tanzania also trades more with the ROW than with the SADC region (regional imports account for only 0.5% of local needs), and has high domestic absorption rates. Therefore SADC tariff elimination, though triggering up to a 100% increase in trade with the region, also generates small responses on the domestic market. Both Tanzanian and Mozambican exports to the ROW currently face very low tariff rates, with sector weighted averages of less than 0.1%, so that intra-region tariff reforms provide little incentive to increase exports to the region. For coastal countries, trading with the world by sea may be cheaper than trading with the SADC region by rail or road. Indeed trade with the rest of the world remains almost unchanged after intra-SADC tariff elimination. We note again that net private net welfare gains are also positive for these two countries.

The welfare effects from unilateral MFN tariff reforms indicate that the region stands to gain much more on the consumption side, than would be expected from intra-region tariff reform alone. Significant increases in cereal imports into the region are expected, triggering price drops of up to 6%. Increases in quantities demanded of about the same magnitude are expected, although regional output is expected to drop by almost 5%. The regions' exports to the world also increase, though aggregate supply is expected in to increase universally. Results also indicate that the gains in consumer welfare are much higher than the losses in producer surplus, so that the net welfare gains are much higher than would be expected with intra-regional tariff reforms alone. These results seem to support the notion that exclusionary regional trade agreements run the risk of diverting trade away from more efficient producers, towards less efficient, preferred producers. In the case of SADC, it seems South Africa benefits from being both the largest producer in the region (produces approximately 50% of regional output) and a convenient market for ROW exports due to location and relatively low protection rates (import-weighted tariff rates in the cereal world market is about 14%). When only SADC trade is freed, both South Africa's exports to SADC, and its imports from the ROW[9], increase. When the region opens to the global markets, this competitive edge is lost. The negative net welfare effects expected for South Africa under this policy scenario are of the nature discussed above for the rest of SADC under intra-regional tariff reforms: positive net 'private' welfare gains, nullified by larger losses in tariff revenues.

The second policy option, however, could have negative income, hence food security implications, for net sellers of cereals in the region. Depending on country-specific profiles of the rural population, the food security status of the country on aggregate may worsen. The proportion of production retained for home consumption relative to cash sales, as well as the relative differences between the selling and buying prices, would determine whether producers will experience welfare improvement or losses from these expected price changes. Producers who are net buyers may in fact benefit from lower prices, if they gain more from lower consumer prices than they lose in income from lower producer prices. On the other hand, the price effects on strict buyers of grain, who make up around 30% of SADC's population, are unambiguous: lower prices necessarily translate to higher welfare.

4.2 Simulation 3: Partial Tariff Reforms

Let us assume a hypothetical situation in which only some of the countries in the SADC region do not fully liberalize their cereals sectors. In this simulation, the assumption that COMESA countries, Zimbabwe, Zambia and Malawi, (with historically highly regulated cereals sectors) fail to fully liberalize. For simplicity, we make the assumption that these three countries do not participate in any form of tariff reforms, while the rest of the region implements complete intra-regional tariff reforms. Results from this simulation are presented in Table 4.

[9] In response to higher internal prices in the South African market. Notice that South Africa's tariff revenues increase as well.

Table 4a: Partial Tariff Reforms, Price and Trade Effects

	Overall Consumer Price % Change	Producer Price for Home Goods % Change	Output % Change	Domestic Absorption % Change	Exports to SADC % Change	Imports from SADC % Change	Total Supply % Change
Botswana	-2.05	-0.91	-0.7	-3.8	9.8	3.3	1.87
Lesotho	0.02	0.02	0	0	0.3	0.09	-0.01
Malawi	0.05	0.06	0	-0.1	24.2	-0.03	-0.05
Mozambique	-0.25	-0.17	-0.1	-0.2	1.2	16.9	0.19
Namibia	0.41	0.92	0.7	-2.9	39.4	1.5	-0.35
South Africa	0.11	0.13	0.1	-0.2	3.9	5.9	-0.11
Swaziland	0.08	0.12	0.1	-0.3	2.1	0.1	-0.06
Tanzania	-0.20	-0.12	-0.1	-0.2	9.0	98.9	0.17
Zambia	0.11	0.10	0.1	0	17.6	-0.4	-0.06
Zimbabwe	0.57	0.61	0.5	-0.6	19.4	2.1	-0.32
other SADC	-0.43	-0.29	-0.2	-0.3	13.5	43.1	0.40

Table 4b: Partial Tariff Reforms, Welfare Effects

	Consumer Surplus Change US$'000	Producer Surplus Change US$'000	Tariff Revenue Change US$'000	Net Welfare Effect US$'000	Net Private Welfare Effect US$'000
Botswana	1804.3	-147.4	-1894.5	-237.6	1657
Lesotho	-18.1	12.8	-43.5	-48.7	-5.3
Malawi	-317.5	291.7	7.4	-18.4	-25.8
Mozambique	941.3	-525.9	-492.1	-76.7	415.4
Namibia	-212.5	222.3	-10.0	19.8	9.8
South Africa	-2999.2	3573.4	-35.7	538.4	574.2
Swaziland	-37.2	22.1	-21.6	-36.6	-15.1
Tanzania	1741.0	-941.1	-1019.0	-219.1	799.9
Zambia	-428.9	340.0	5.5	-83.4	-88.9
Zimbabwe	-4441.9	4658.9	206.2	423.2	217
other SADC	3648.8	-1058.3	-35144.5	-924.1	2590.5

In all three COMESA countries, both producer and composite consumer prices would increase as a result of tariff reforms in the rest of the region. Producer prices increase because as the rest of SADC opens up, new markets are opened for COMESA exports, while imports into COMESA countries from SADC and from each other do not change much. Aggregate supply (output + imports – exports) in these countries is expected to drop.

For the net-importer COMESA countries, Zambia and Malawi, the loss in consumer surplus due to higher consumer prices is much higher than the benefits to producers, so that these countries still experience net welfare losses even if they do not participate in the regional tariff reforms. The welfare losses are however much lower than expected when these countries participate in the FTA. For Zimbabwe, a net exporter to the region, the gains in producer surplus exceed the losses in consumer surplus, and positive net welfare effects are expected. The net private welfare gains are much smaller for all three countries. For the rest of the SADC region, the price effects are less than expected with region-wide reforms, while maintaining the same general trends. Both the net welfare effects and the private net welfare effects do not seem to follow any particular trends, with the only notable change being that the SACU countries expected to lose most from broader SADC reforms earlier are now in a better welfare state. Therefore the implications of failure to participate in the tariff reform process by some countries seems to be lower private net welfare gains for the defecting nations, whereas the region as a whole experiences smaller but not necessarily worse welfare responses.

4.3 Simulation 4: Intra-SADC Supply shock

In this simulation, the effect of a supply shock originating from one SADC country – South Africa – is evaluated. South Africa is chosen because it is the only country in the region that trades bilaterally with all of SADC. The effects of incremental hypothetical drops in South Africa's output are evaluated and results from a 20% decrease in output presented here (inter-seasonal output variability in South Africa has ranged from -45% to 67% around the mean in the past 25 years). Ordinarily, given the similarity in climatic conditions for distinct subsets[10] within the region, climate related supply shocks will likely affect more than one country in the region. For the sake of maintaining tractability of this analysis, we assume that the supply shock is only experienced in one country. Two simulations were run: first evaluating the effects of the supply shock in the absence of tariff reforms, then after the implementation of region-wide tariff reforms.

[10] For example South Africa, Mozambique, Lesotho and Swaziland

Table 5: 20% Production Shock in South Africa

	Composite Market Price (% change)	Regional Imports (% change)	Regional Exports (% change)	Domestic Absorption (% change)	Total Supply (% change)	Overall Welfare Effects ($'000)
Botswana	4.97 (4.56)	-10.35 (-9.15)	2.88 (2.70)	7.08 (6.79)	-7.43 (-6.70)	-3 310.5 (-3 283.8)
Lesotho	5.60 (5.50)	-13.56 (-13.40)	0.76 (0.75)	5.22 (5.12)	-4.70 (-4.48)	-2 520.3 (-2 469.3)
Malawi	1.43 (1.56)	-12.97 (-12.32)	0.01 (-0.09)	1.38 (1.52)	0.33 (0.32)	-1 903.7 (-1 828.8)
Mozambique	0.52 (0.58)	-31.51 (-30.74)	4.21 (4.56)	0.37 (0.38)	-0.27 (-0.34)	-811.6 (-755.9)
Namibia	3.14 (3.05)	-24.6 (-24.32)	2.80 (2.64)	3.83 (3.98)	-2.33 (-2.23)	-1 025.9 (-998.9)
South Africa	6.60 (6.48)	9.97 (10.24)	-24.4 (-24.93)	-11.50 (-11.39)	-6.56 (-6.39)	11 837.3 (14 414.1)
Swaziland	6.28 (6.17)	-11.38 (-11.25)	0.75 (0.51)	6.90 (6.82)	-5.26 (-5.14)	-2 210.4 (-2 170.3)
Tanzania	0.09 (0.13)	-28.16 (-27.36)	4.90 (4.97)	0.04 (0.08)	-0.06 (-0.13)	-425.3 (-317.8)
Zambia	1.51 (1.76)	-22.98 (-23.78)	4.52 (2.91)	1.60 (1.88)	-1.95 (-2.41)	-2 854.5 (-2 688.4)
Zimbabwe	1.22 (1.56)	-28.30 (-27.36)	9.25 (8.20)	0.90 (1.25)	-1.20 (-1.89)	-4 036.8 (-3 407.3)
otherSADC	0.29 (0.37)	-28.70 (-27.84)	7.83 (8.34)	0.29 (0.36)	-0.18 (-0.32)	-1 879.5 (-1 572.9)

*Pre and (post) tariff reform welfare effects

The results presented in Table 5 indicate that a supply shock generated in South Africa is likely to cause major price increases throughout the region, highest for SACU countries and lowest for countries whose trade with South Africa is limited, such as Tanzania. Domestic absorption is also expected to increase universally (countries reduce exports), but aggregate supply is expected to drop in each country due to lower imports from the region (specifically from South Africa). The magnitude of these responses seems to not change much after intra-regional tariff reforms, although in this case, the price increases expected for SACU countries is lower, and that for the rest of the region higher, than in the restricted trade case. Tariff reforms therefore seem to serve the purpose of spreading risk of a supply shock, making it less intense in the country origin (in this case South Africa and other SACU countries) and more intense for the rest of SADC, considering though that the differences are small.

3.4 Simulation 5: Supply shock from the rest of the world

We test here the thesis that increased openness in trade among SADC countries reduces individual countries' vulnerability to external (extra-regional) supply shocks. The effect of a hypothetical 5% supply shock generated on the world market is evaluated, and results are presented in Table 6.

Table 6: 5% Production Shock in World Market

	Composite Market Price % change	Regional Imports % change	Regional Exports % change	Domestic Absorption % change	Total Supply % change	Overall Welfare Effects $'000
Botswana	2.22 (2.16)	-0.86 (-0.88)	0.86 (0.85)	-1.29 (-1.72)	-2.63 (-2.56)	-1 608 (-1 598)
Lesotho	2.06 (2.07)	-1.83 (-1.83)	0.17 (0.17)	-0.06 (-0.06)	-1.64 (-1.65)	-777 (-777)
Malawi	2.11 (2.10)	-2.87 (-2.92)	1.68 (2.57)	0.21 (0.18)	-0.72 (-0.73)	-2 079 (-2 094)
Mozambique	3.47 (3.44)	4.35 (4.18)	-5.32 (-5.17)	0.66 (0.71)	-2.65 (-2.64)	-4 605 (-4 599)
Namibia	3.63 (3.68)	4.36 (4.50)	0.42 (0.43)	-0.13 (-0.27)	-3.07 (-3.18)	-1 281 (-1 276)
South Africa	2.65 (2.66)	1.45 (1.48)	-0.54 (-0.51)	-0.11 (-0.08)	-2.74 (-2.78)	-18 772 (-18 343)
Swaziland	2.08 (2.08)	-1.97 (-1.98)	2.79 (2.81)	-0.25 (-0.26)	-1.74 (-1.75)	-643 (-643)
Tanzania	2.88 (2.84)	2.00 (1.82)	-1.13 (-0.02)	0.25 (0.31)	-2.31 (-2.25)	-10 942 (11 093)
Zambia	1.66 (1.69)	-2.77 (-2.80)	2.16 (2.51)	-0.01 (-0.02)	-1.45 (-1.43)	-1 582 (-1 592)
Zimbabwe	1.63 (1.68)	-3.24 (-3.13)	2.35 (2.22)	0.06 (0.04)	-1.37 (-1.39)	-2 705 (-2 681)
otherSADC	5.22 (5.14)	10.46 (10.11)	-11.0 (-10.45)	0.51 (0.50)	-4.83 (-4.74)	-31 390 (-31 230)
ROW	6.25 (6.25)	15.31 (15.36)	-15.66 (-15.86)	-4.38 (-4.38)	-4.38 (-4.38)	-283 265 411 (-283 256 463)

*Pre and (post) tariff reform welfare effects

The price effects, as expected, are higher for countries that trade significantly with countries outside of the region, such as Angola and DRC (under the 'other SADC' group of countries), Namibia, Mozambique, Tanzania and South Africa. Countries like Tanzania and South Africa that, in addition to trading with the world, are near self sufficient, are more capable of absorbing the supply shock, and the prices effects in these countries are lower than expected in their less self-sufficient counterparts. A country like Namibia, on the other hand, with only 41% local contribution to domestic requirements, suffers higher price effects. Aggregate supply in the whole region is expected to drop, even for countries that do not trade much with the world. What is more interesting, though, is the closeness in magnitude of change between the closed and more open market scenarios – emphasizing the earlier conclusion that intra-SADC tariff reforms alone do not generate major effects on the prices and output levels of the region. The trend of whether or not increased regional integration reduces (on the margin) individual countries' vulnerability to external supply shock appears inconclusive, with country responses depending on pre- and post-reform trade relation with the rest of the world.

One of the topical issues in the trade and food security debate is the effects of subsidies in the developed world, which generally translate to increased supply on the world markets and/or increased dumping in developing country markets, mainly in the form of food aid. The SADC region has not been exempt from these global trends, with food aid comprising up to 20% of total imports into the region in specific years (SADC FANR 1996-2006). An interesting assessment therefore is to evaluate the extent to which increased inflow of grain from the world market would affect regional prices, both in the presence of regional tariffs, and after tariff reforms[11]. The assumption that the increase in world supply to the SADC region is absorbed by countries according to current proportions of world imports is made, whereby each country in the region faces an equal proportional shift in their ROW excess supply function. In practice, increases in world supply to the region are likely to be targeted to specific countries, with indirect impacts on third countries. The assumption is made to maintain tractability of simulation results.

Results indicate that effects of increased supply from the rest of the world are quite similar to what would be expected under region-wide MFN tariff reforms discussed in section 4.1 above: universal price drops are expected, coupled with increased local supply of cereals, and higher (positive) net welfare gains. Regional openness does not seem to exacerbate these effects in any significant manner, although this result might change with the relaxation of the 'proportional dumping' assumption. If the increase in ROW imports affects only a few

[11] It is not clear from the national trade statistics recorded in WITS for each SADC country whether food aid is included as part of the imports data or not, or in which cases it is subject to the same tariff rates imposed on commercial imports. What is clearer is the fact that the SADC secretariat and FAOSTAT cereals balance sheet record 'imports' as the sum of commercial imports and aid, and that in most cases, goods brought in through NGOs are tariff exempt – though in most cases these exemptions are rather ad hoc and case specific (Mudungwe 2002).

net-importer countries, to the extent that (1) aggregate supply in these countries exceeds consumption needs at prevailing world prices, and (2) intra-SADC rules of origin are not fully enforced, then through indirect transfer of grain, the effects of ROW imports would be similar to those assessed above. However if aggregate supply is completely absorbed by the deficit nations at prevailing world prices, and/or rules of origin are properly enforced, the effects of increased ROW imports will be localized within recipient countries both in the case of restricted trade and after tariff reforms. These analyses are beyond the scope of this study.

Table 7: 20% Proportional Increase in Supply from World Market

	Composite Consumer Price % change	ROW Imports % change	Domestic Absorption % change	Total Supply % change	Overall Welfare Effects $'000
Botswana	-1.25 (-1.20)	27.5 (27.7)	0.28 (0.70)	1.7 (1.67)	966 (955)
Lesotho	-1.00 (-1.01)	28.5 (28.3)	-0.64 (-0.64)	0.88 (0.90)	439 (443)
Malawi	-1.23 (-1.21)	27.5 (27.6)	-1.16 (-1.12)	-0.15 (-0.14)	1 673 (1 654)
Mozambique	-2.60 (-2.58)	21.6 (21.7)	-2.79 (-2.81)	1.94 (1.94)	5 139 (5 147)
Namibia	-2.89 (-2.95)	20.6 (20.4)	-2.28 (-2.23)	2.42 (2.55)	1 268 (1 276)
South Africa	-1.69 (-1.71)	25.8 (25.7)	-1.74 (-1.77)	1.79 (1.85)	25 541 (25 589)
Swaziland	-0.99 (-1.00)	28.5 (28.4)	-0.45 (-0.45)	0.85 (0.86)	329 (332)
Tanzania	-1.96 (-1.97)	24.4 (24.4)	-1.95 (-1.92)	1.52 (1.49)	13 794 (13 825)
Zambia	-0.66 (-0.66)	29.7 (29.7)	-0.69 (-0.69)	0.98 (0.94)	1 264 (1 226)
Zimbabwe	-0.75 (-0.77)	29.2 (29.2)	-0.68 (-0.67)	0.96 (0.93)	2 958 (2 871)
otherSADC	-4.80 (-4.71)	13.0 (13.3)	-4.88 (-4.76)	4.46 (4.35)	36 343 (36 312)

*Pre and (post) tariff reform welfare effects

5. Sensitivity Analyses

5.1 Parameter Estimates

To evaluate robustness of the results obtained from the GSIM analysis, the following sensitivity analyses were performed: (1) using different supply elasticities, (2) using different values for the elasticities of substitution, and (3) using tariff rates obtained from the different tariff-line aggregation methods described in section 3.2.

The main purpose of these simulations is to ensure that results are not sensitive to the choice of elasticity values or tariff aggregation methods. The simulation outputs from selected sensitivity tests are included in Appendix 2.

Results from the sensitivity tests support the overall results discussed in section 4.1, if not with similar magnitudes of change, at least with the same direction of change. Lower elasticities are shown to be consistent with much lower production responses, tending to reduce the expected welfare gains from higher producer prices, as well as the expected welfare losses from lower producer prices for countries like Malawi, Zambia and Zimbabwe. Higher supply elasticities are associated with smaller producer price effects and larger output effects than those predicted with an export supply elasticity of 0.8. However, even at very high elasticity values of say 100, net welfare effects are still negative for most of SADC, although the SACU countries Lesotho, Namibia and Swaziland, fare better with higher regional output response. Lower elasticities of substitution are consistent with lower quantity and price responses, hence smaller welfare effects, maintaining the same trends observed with an elasticity of substitution of 5. Here again, increasing degree of substitutability by as much as twenty-fold (increasing substitutability between imports) will neither affect the expected direction of change, nor move the region into the positive net welfare range. Different tariff aggregation methods produce, in specific cases, some non-trivial differences in sector-level tariff protection rates. In Malawi, for example, the average tariff rate obtained from the import weighted average aggregation method is 1%, whereas the global unit value weighted sum method gives a 4% rate, and the simple average method a 16% rate. These differences translate to some significant differences in net welfare effects. When the higher simple average tariff rates are used, for example, a few additional countries would now expect positive net welfare gains from tariff reforms. This result seems to indicate that if indeed effective protection in this highly regulated sector exceeds tariff rates used in this analysis, the net welfare effects computed here would be an underestimation of what we can expect with full-fledged trade policy reforms.

5.2 A General Equilibrium Assessment

Partial equilibrium models are often criticized for failing to capture the complex inter-sectoral linkages that often exist in an economy. This implies that resource re-allocation among sectors is not taken into account, and the gains/losses from policy reforms could be overestimated. This hypothesis is tested by running comparable policy simulations using a global computable general equilibrium model – the Global Trade Analysis Project (GTAP) – that allows for inter-sectoral adjustments. Expected welfare effects of tariff reforms are then compared to those obtained using the GSIM model. In comparing these results, we note that because the GSIM and GTAP models are fundamentally different models structurally, as evidence from the model structure discussion below, and are based on different assumptions on the structure of utility functions, elasticities, and measures of welfare, direct comparisons of results would be erroneous. Additionally, some of the differences in underlying model data, for example elasticities, tariff line concordance, tariff rates, production, consumption and trade volumes, were extremely difficult to reconcile. Some of the irreconcilable differences encountered were:

- SADC countries appearing in the database. Of the 13 SADC countries included in this study, only 7: Botswana, Malawi, Mozambique, South Africa, Tanzania, Zambia and Zimbabwe, are explicitly included in the GTAP database. The rest are aggregated into 'other SACU' and 'other SADC' countries.
- Sector concordance. Only two of the cereal commodities under study: wheat and rice appear in disaggregated form in the GTAP database. The rest are aggregated into 'other cereals' and all the processed cereals are included as part of a much broader 'other food' sector. The challenge in consolidating these data to those used in the GSIM is that tariffs come already aggregated, and it is not clear what the original tariff-line values were, or how the aggregation was performed. Sector level tariff rates for SADC countries are generally lower than those appearing in other databases, such as WITS and the SADC secretariat.
- Other statistics such as production, consumption and trade data must be taken as is in the GTAP database and where they differ from the GSIM data, cannot be changed.

Regardless of these differences, some useful insights can be drawn from this analysis. An attempt was made to reconciles these differences to increase comparability of results, for example, the much lower tariff rates appear in GTAP were transformed to an equivalent of the GSIM tariffs. Thus the purpose of this analysis is not to make one-for-one comparisons of predicted welfare effects, but to evaluate the robustness of the *general trends* predicted by the GSIM analysis. The GTAP model has the added advantage that it captures a feature of the SADC cereals sector, that a significant number of producers (between 4 and 16%, Jayne et al 2005) are also net buyers of cereals, through the assumption of a single regional household that is both an owner of the factors of production from which household income is derived, and a consumer. This assumption also allows us to evaluate the household welfare effects of losses in government revenues. However, whereas the GSIM model enables explicit decomposition and quantification into dollar values of welfare effects on different household groups – the main objective of this study – the GTAP model provides more aggregated welfare effects in percentage terms, and disaggregation of welfare effects into producer and consumer surplus is not feasible.

The GTAP model is a static general equilibrium model, comprising a regional household involved in consumption, savings and government spending decisions, where expenditure is distributed in fixed shares among these household decisions. The model assumes an explicitly additive Cobb Douglas aggregate utility function modeled through a non-homothetic Constant Difference of Elasticities function, which simplifies to a CES function when the assumption of constant elasticity of substitution is made:

$$(1) \qquad \sum_{i\epsilon Trade} B_{(i,r)} \text{ x } U_r^{\beta(i,r)\gamma(i,r)} \text{ x } [P_{(i,r)}/E(P_r,U_r)]^{\beta(i,r)} \equiv 1$$

where, for a regional household *r*, $\sum_{i\epsilon Trade}$ is the sum over the set of traded goods *i* consumed by the private household, and $B_{(i,r)}$ represents distribution parameters, $\beta_{(i,r)}$ substitution parameters, and $\gamma_{(i,r)}$ expansion parameters. $P_{(i,r)}$ is the price of commodity *i* and E(.) is the minimum expenditure required to attain a pre-specified household utility level U_r, at the private household price vector P_r. This functional form simplifies to a CES function when $\beta_{(i,r)} = \beta$ for all *i*, and to a Cobb Douglas function when $\beta = 0$.

Current government expenditures are used to proxy the welfare gained from public goods and services provided to private households (thus allows us to evaluate the household welfare effects of losses in government revenues, unlike GSIM). Savings enter the utility function directly, where optimal savings are deduced from the utility maximization problem. Changes in private income and utility from policy reforms is measured by the percentage change in private utility in a given region, which is a function of changes in private household incomes, the share of the specific good in total consumption, and the income elasticity of demand:

$$(2) \qquad u_r = (y_r - \sum_{i \epsilon Trade} [\theta_{(i,r)} \text{ x } p_{(i,r)}])/ \sum_{i \epsilon Trade} \theta_{(i,r)} \text{ x } \eta_{(i,r)}$$

where u_r is the *percentage change* in private utility in region *r*, y_r is the *percentage change* in private household income in region *r*, $\theta_{(i,r)}$ is the share of good *i* in total consumption, $p_{(i,r)}$ is the *change in the demand price* of commodity *i*, and $\eta_{(i,r)}$ is the income elasticity of demand for good *i* – restricted to be positive and greater than one for superior goods with non-homothetic preferences (equals one when preferences are homothetic).

Household income is defined as the sum of the value of the household's endowments, divided in the model into five broad categories: land, unskilled labor, skilled labor, natural resources and capital:

$$(3) \qquad Y_r = \sum_{j \epsilon Endowments} Q_{e(j,r)} \text{ x } P_{e(j,r)}$$

where Y is total income, $Q_{e(j,r)}$ is quantity of endowment *j* and $P_{e(j,r)}$ is its price. Change in income from policy reform is then defined as:

$$(4) \qquad y_r = \sum_{j \epsilon Endowments} \varphi_{e(j,r)} \text{ x } p_{e(j,r)}$$

where $\varphi_{e(j,r)}$ is the income share of a given endowment, and $p_{e(j,r)}$ is change in the endowment price. Using this model specification, we can evaluate the percentage changes in domestic and import prices, income, demand, supply, consumption expenditure and per capita utility for the regional household in a given region. The welfare changes resulting from a price shock are summarized in dollar values using a money metric equivalent of utility change – the equivalent variation.

In this simulation, intra-regional tariffs are eliminated on cereals imported from the SADC region, but maintained on cereals imported from the world. Results from intra-regional tariff reforms using the GTAP model (Table 8) indicate again that the expected price and welfare effects of tariff reforms in the cereals sector of the SADC region are rather small. It appears that in the general equilibrium setting, expected price and welfare effects are even smaller than predicted by the partial equilibrium model. With a few exceptions[12], the general trend in expected welfare responses is similar to that expected in the GSIM model, though at smaller magnitudes. Notably, net welfare effects are either negative or almost negligible for most of SADC, COMESA countries are still expected to experience drops in producer and consumer prices, producer prices are expected to increase in SACU countries, welfare gains are highest for South Africa, and negligible welfare effects are expected for Tanzania. Domestic absorption is still expected to drop universally, and the supply response to be small. These results thus seem to highlight similar trends and support the earlier conclusion that expected price and welfare effects of intra-regional tariff reforms in the cereals sector of the SADC region are small and generally negative[13].

Table 8: Price and Welfare Effects, GTAP model

	Composite Market Price (% change)	Domestic Supply Price (% change)	Domestic Output (% change)	Domestic Absorption (% change)	Equivalent Variation (% change)	Overall Welfare Effects (% change)
Botswana	-0.02	0	-0.01	-0.05	-0.04	-0.03
Malawi	-1.54	-0.23	-0.94	-13.74	-0.42	-0.29
Mozambique	-0.38	-0.09	-0.39	-4.75	-0.25	-0.19
South Africa	0.03	0.06	0.64	-0.63	3.64	2.55
otherSACU	-0.02	0.01	0.02	-0.03	0.04	0.04
Tanzania	-0.04	-0.01	0.03	-0.51	-0.08	0.00
Zambia	-0.55	-0.14	-0.87	-8.37	-0.07	0.01
Zimbabwe	-0.16	0.02	0.2	-5.32	0.17	0.11
otherSADC	-0.57	-0.04	-0.2	20.26	-0.21	-0.10

6. Discussion of Results

6.1 Some Food Security Implications

Food security has been defined by FAO as the condition in which ‘all people, at all time, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an

[12]Botswana and Mozambique: with price and welfare effects expected to be smaller and slightly higher respectively, than earlier predicted.

[13] We also note that because applied welfare analyses, such as the one performed here, are second best evaluations that take into account the policy distortions already in existence in an economy, in principle, trade liberalization may fail to improve welfare if it leads to resource re-allocation from one distorted sector to an even more distorted one (Francois and Reinert, 1997).

active and healthy life' (FAO, 2004). Physical availability means that enough food is produced to meet current demand, whereas economic access entails that consumers possess enough purchasing power to afford basic food requirements at prevailing market prices. Although the analysis performed in this study cannot say much about how the safety or nutritional content of food changes, it helps illuminate the food security issue from the perspective of physical and economic access.

Let us first consider physical access. The production and consumption trends in the SADC region for a period of 12years, 1990 to 2001, indicate that the SADC region is a net surplus producer of cereals for food consumption (excluding animal feed and seed requirements), with average regional demand accounting for about 90percent of regional production. South Africa is the only net surplus producer and contributes about 50percent of this supply (see Appendix 2). Therefore it seems that the food security issue, at regional level, is more an issue of access than it is an issue of availability (bearing in mind though that in practice, food security is a household, as opposed to a regional, concept). The point here is that the region currently produces enough to feed its people. What is more pertinent is whether the lowering of tariffs produces enough incentive for cereals to move from surplus to deficit areas. Results from this study indicate that from a regional perspective, freer intra-regional trade has the effect of increasing regional supply of cereals very minimally, by a proportion of 0.1percent (equivalent to 26,000 tons), whereas unilateral MFN tariff reforms increase supply by over 3% (848 000 tons). Domestic absorption is expected to drop universally as countries become more open, implying a universal loss in self-sufficiency. On a country level, intra-regional tariff elimination leads to an even lower aggregate supply reaching some of the deficit countries, notably the some of the deficit SACU countries, while aggregate supply in the rest of the region remains more or less the same. Unilateral MFN tariff reforms on the other hand, lead to universal increases in aggregate supply at country level. The implication of these results is that intra-SADC tariff reforms perform poorly as a means of improving physical availability of cereals to deficit nations, as supply of cereals in the SADC region appears fairly irresponsive to intra-regional tariff reforms, at least in the short run. Reform of the broader MFN tariffs performs much better as a strategy for improving aggregate supply of cereals to the SADC region.

Noting that food security is not about expanded food production per se, but rather about improving the capacity to generate income and to consume (through lower consumer prices, higher incomes or both), we are also concerned with the effects of tariff reforms on economic access to cereals in the SADC region. Theoretically, removing tariffs, either at regional or global level, generates two positive income effects: first reducing the cost of transaction for the producer, and second, reducing the final price paid by the consumer (holds true regardless of whether the FTA produces trade diversion or not). Overall, results from this study appear contradictory to this expected outcome, and the initial policy recommendation that improved intra-trade would improve food security for SADC countries, as the net welfare effects of intra-SADC tariff reforms are negative for all countries in the region except South Africa. However at close inspection, these results may not be far from supporting these assertions, mainly because when assessing potential benefits of openness to food security, the tendency is to focus mostly on household welfare – how consumers in deficit areas and producers in surplus areas are likely to be affected, and if positively, generally expecting an improvement in overall food security status. In most cases, very little attention is paid to the effects on tariff revenues, even though as this study shows, these revenue losses may make all the difference in terms of whether the overall welfare effects are positive or negative. Let us evaluate this issue more closely.

Results from the analysis indicate that in the best case scenario, when only 'private' net welfare effects are considered (by disregarding government revenue losses), positive net welfare effects are expected for the SADC region[14]. From this perspective, overall economic access to food is expected to improve – albeit meagerly – at regional level, from freer intra-regional trade. This scenario is not unreasonable, considering that the tariff revenues obtained from the cereals sector are generally insignificant relative to total government revenues (less than 1%), and therefore are not likely to produce any significant drops in total government expenditure. In addition, actual revenues collected from tariffs in developing countries have been shown to be often lower than the levels predicted by applied models, a result of collection inefficiencies and numerous exemptions and rebates that are generally not well documented. Tsikata 1999 computed the collection efficiency ratios (defined

[14] Exceptions at country level include Namibia, Lesotho and Swaziland.

as the implicit tariff collection ratio[15] expressed as a function of the statutory rate) for South Africa and Zimbabwe, and obtained valued of 65.2% and 53.4% respectively. Thus the real income effects of lower revenues are most likely lower than expected. Moreover, preferential trade agreements usually come at a high administrative cost to participating countries that most applied models do not account for, through increased number of tariff schedules, and to enforce control policies such as the rules of origin. Since higher tariff revenues may not necessarily translate into improved availability of food, the food security effects of these revenue drops may be very small. Thus, in assessing the food security effects of trade reforms, focus is often placed on the producer and consumer – where direct food decisions are made.

However if we consent that government revenues are an equally important component of a nation's food security, then overall income available to pursue physical and economic access to food would decrease with lower government revenues, then the food security status of the SADC region would worsen with intra-regional tariff reforms, improving considerably with indiscriminate reform of MFN tariff rates. It is important to note that even in the best case scenario, the gains to household welfare from freer regional trade are small, much smaller compared to the benefits expected with multilateral liberalization (about 87% less). These results seem to suggest that intra-regional trade can only work as a viable food security if it is used as a precursor to integration with the global markets.

Another equally important dimension of access to food is stability of supply and prices. Results from the supply shock simulations indicate that when supply shortages are experienced in one country, the bulk of the price variability is experienced only in that country and its current major trading partners. Although the general impact of greater regional openness is to smooth out country level supply and price variations, lowering the impact in the countries directly affected by the shock, while increasing the impact for the rest of the region, tariff reforms alone are not enough to effectively smooth these effects out. The general responses to supply

[15] The implicit tariff collection ratio is simply the actual duty collected as a percentage of CIF value of imports. By expressing this value as a proportion of the statutory rate we obtained the extent to which the collected tariff revenues deviate from the expected revenues.

shock do not change much after regional tariffs have been removed. This study does not address the issue of intra-seasonal continuity in supply, but shows increased grain mobility within the region as a result of tariff reforms.

A few caveats are in order. First, food security is a household phenomenon. This study attempts to disaggregate welfare effects at national producer and consumer level, however, to reach even more meaningful household level food security conclusions, a deeper understanding of household decomposition for each country is required, to ascertain for example, the proportion of net sellers, net buyers and self sufficient households; as well as the proportion of income derived from cereals or allocated to cereal consumption. For example, consider rural household *A* in Malawi. After tariff reforms – *A*'s purchase price for cereals drops by almost 2%, whereas its sale price drops by only 1%. If *A* is a net seller of one or more cereal commodities, then depending on the extent to which sales exceed purchases as well as the extent to which consumer prices exceed producer prices, *A* could either gain or lose from the tariff reform process. If *A* is a net buyer of cereals, then household food security improves on the margin, and if *A* is a self-sufficient household these price changes will not affect its household welfare at all. Such information would shed more light on the more micro level effects of the reforms discussed in this paper[16].

In addition to determining if the increase in net welfare is beneficial to most people, we also need to understand the profile of the households benefiting – are these the currently food insecure? For example, although South Africa appears as a food surplus nation on aggregate, some population groups within South Africa continue to experience hunger and malnutrition from insufficient, unstable food supplies, at the household or intra-household level. The majority of producers in the former homelands, like most smallholders in the region, are

[16] Note that with the exception of large scale commercial producers, most producers of cereals in the SADC region are both buyers and sellers of cereals, especially the staple grains. Evidence from Southern Africa suggests that generally less than 50% of rural producers of cereals are net sellers, and that over 70% of the sales are concentrated in about 10% of these households (Weber et al 1988). According to Jayne et al 2005 only an estimated 4 to 21% of the producers in the region are strict sellers (higher percentage in countries with a dual agricultural sector), and between 8 and 39% are subsistence producers. Weber et al 1988 also suggest that increased food prices would benefit only a minority of producers who are heavy net sellers, and that even in cases where poor farmers would have benefited, they normally face supply-side constraints that hinder them from taking full advantage of these price incentive. Consumption, on the other hand, responds more rapidly to changing prices.

deficit producers and are susceptible to even non-catastrophic events such as seasonal or climatic variations. On the hand, large scale commercial producers, who are the majority of the surplus producers in the country, are likely to capture the welfare benefits predicted here, although they are certainly not among the currently food insecure population of the nation. Similarly, if a country like Malawi, that benefits on the consumer side, has say very high levels of self sufficiency among the rural and urban poor, the lower consumer prices would only benefit the urban elite, who are not currently food insecure. Therefore is assessing the food security benefits to such households from the seemingly positive aggregate producer/consumer welfare gains, it is important to consider these inter-household differences.

Although this study addresses inter-seasonal supply and price variability, the annual statistics used in this analysis tend to smooth out intra-seasonal price fluctuations, and mask the intra- seasonal nature of food supply. It is these intra-seasonal shortages and price escalations, however, that are usually the major causes of hunger in the region. For example, in the 2004/05 growing season, the price of maize in Mozambique's urban markets increased by 60% between the month of July and January (FEWS NET 2005). Such price increases would ordinarily serve as the source of cross-border trade incentives. Evidence from the region however suggests that tariff barriers (evaluated in this study) are not the main barrier of trade during such shortage periods. Mano et al 2003 observe that it is at these times of shortages and price hikes that non-tariff trade policy comes into effects, nullifying the incentives for increased regional trade. Thus given the current non-tariff policy environment in the region, and the annual statistics used in this analysis, tariff reforms do not seem to cause/alleviate major price variability in individual countries even when a supply shock is experienced.

6.2 How Results Compare to the Literature

Overall, the results from this study indicate that on net, elimination of intra-regional tariffs is welfare reducing for the region (a robust result, as indicated by the sensitivity tests performed in section 5), whereas unilateral elimination of tariffs on all imports is welfare improving. This is an interesting result because it seems to indicate an absence of capacity in the SADC region to respond sufficiently to price incentives (aggregate supply fails to respond even with higher supply elasticities). All the more interesting is the observation that net welfare gains are also expected to be positive when the SADC region eliminates tariffs on imports from the world, maintaining current levels of protection on imports from the region. These results seem to support the notion that exclusionary regional trade agreements could be welfare reducing, since they risk diverting trade away from more efficient producers, towards less efficient, preferred producers (Hoekman and Scheiff 2002). We observe that when tariff reforms are intra-regional, imports from the ROW drop for most net-importer SADC countries, while trade with the SADC region generally increases (indicating trade diversion); whereas non-discriminate tariff reforms generally lead to increased imports from both the region and the world.

Hoekman and Schieff 2002 predict that developing countries are more likely to lose from South-South FTAs because such arrangements entail little or no beneficial trade creation. They argue that a high probability exists that one of the members may gain – usually the most advanced country with a more developed manufacturing sector and is thus the closest competitor with the ROW – whereas the rest of the region would lose. They also suggest that in order to reduce asymmetric distribution of the gains and losses of integration, member of an FTA must also reduce external tariffs to lessen the chances of trade diversion. The results from this study support these arguments: when the external tariffs are maintained at current levels, while regional tariffs are lowered or removed, only South Africa (producer of 50% of the regions' cereals, most industrialized regional country, and close competitor with the world) emerges as a clear beneficiary. The net welfare effects for both the SADC region and the world are in this case negative. When protection against the world is lowered concurrently, net welfare gains improve dramatically for the all countries of the region, except South Africa and Zimbabwe that seem to lose (net 'private' gains are however still positive), and the SADC region on net, is better-off. When the region opens to the global markets South Africa's competitive edge is lost, and the welfare effects for producers and consumers are reversed, with a decrease in both producer and consumer prices leading to lower producer surplus and higher consumer surplus.

Prior evidence on the potential effects of lower intra-regional trade barriers from the SADC region, though appearing mixed depending on scope of economic sectors under study, tends to support the results attained in this study. Yeats 1998, in his assessments of the potential benefits to sub-Sahara Africa of increased regional integration, observes that the region 'appears to have relatively little to trade with each other', arguing that the region has a problem of non-complementarity of export advantages and import needs. Using Revealed Comparative Advantage estimates, he shows that countries tend to have common comparative advantages, and concludes that the region faces a 'lose-lose situation concerning policies towards regional trade agreements.' This study also makes the observation that intra-industry trade such as production sharing among members of regional integration arrangements in SSA – a critical component in the success of these arrangements – appears missing. The study concludes that trade reforms along an MFN basis are a 'far more promising option for Africa', arguing that if the region is to enhance its international competitiveness and capitalize on opportunities in foreign markets, exchange of regional preferences alone would be insufficient.

Lewis et al 1999 and Lewis 2001 use a multi-regional CGE simulation model to assess the economic impact of alternative free trade areas between South Africa, the EU and the global market, and find that such FTA initiatives are beneficial for South Africa, in some cases for non-participant SADC countries as well (trade creation effects in all FTAs including South Africa and either the EU or the global market exceeded trade diversion effects). These studies also show that trilateral FTAs (for example between South Africa, the EU and the rest of SADC) yield higher economic gains for SADC countries than a bilateral FTA between South Africa and the rest of SADC. GDP increases of over 4% were predicted in the former scenario, compared to only 0.33% in the later case (real absorption was actually predicted to decrease in the latter case). These studies thus conclude that South Africa is not large enough to serve as a 'growth pole' for the entire SADC region, arguing that access to EU markets provides substantially larger gains for the rest of SADC.

Jachia and Teljeur 1999 also reach similar conclusions in their analysis of the welfare impacts of a South Africa – EU FTA. This study uses the SMART model to show that a North-South Free Trade Agreement between

South Africa and the EU would be welfare improving for both countries and some non-participating SADC countries. South Africa's agriculture sector is in fact predicted to gain the most, from increased exports to the EU. These gains however are predicted to come at the cost of worsening trade balances and significant tariff revue losses for South Africa, and some significant trade diversion for particular countries in the SADC region.

Wobst 2002's study of the impact of domestic and global trade liberalization on five southern African countries used a CGE model to show that tariff cuts in these countries generate limited consumption and output responses. A 50% universal cut in tariffs, for example, is predicted to lead to private consumption and output responses in the region of less than 0.4% and 0.7% respectively. In the same study, the author shows that higher adjustments in the region are expected from macro-economic reforms such as exchange rate reform, than from tariff reforms. These expected responses are similar in magnitude to those predicted by the analyses performed above. In their survey of literature on agricultural supply response to prices in Africa, Weber et al 1988 also draw conclusions from several regions of the continent suggesting limited cereals supply responses to price increases. They review literature suggesting that price policy is likely to be ineffective in improving production and improving broad-based food security in the region.

In a related study – evaluating the trade relations between Malawi and Mozambique – Arlindo and Tschirley 2003 highlight the importance of location of producer and consumer groups in a given country in assessing the potential effects of greater regional openness on their income and food security status. In this study, the authors find that even though increased trade with Malawi causes greater export of cereals out of Mozambique, these come at no significant cost to urban consumers who are currently not within reach to benefits from the surplus output. From this literature two main messages emerge from the southern Africa region: first that tariff reforms alone tend to generate limited supply and consumption responses, that may increase if implemented concurrently with broader macro reforms, and second that intra-regional preferential market access produces very limited, even negative, welfare responses for participating countries, that would increase substantially when the region integrates into the global economy.

6.3 Limitations of the Study

The analyses performed in this study suffer a few limitations worth noting. We first reiterate the model related limitations, also discussed in section 4.1. The GSIM model is based on the representative agent assumption, where the level of responsiveness to price changes is taken to be the same across different income groups and geographic locations. In a region where producer and consumer groups are diverse, in terms of both income elasticity of demand/supply and level of response to changes in border parity prices, consumption and production responses to trade reforms may also differ significantly within countries. The estimated welfare responses also are based on the assumption that price transmissions are complete, and to the extent that changes in border parity prices are only partially transmitted to the household and producer levels, may overestimate actual responses to reforms. Additionally, GSIM is a partial equilibrium model, thus does not take into account the inter-sectoral linkages that may exist between the cereals sector under study and other sectors of the economy. Therefore we might expect again the actual equilibrium responses to be less severe than those predicted in this study. Our analysis of the sector reforms using a general equilibrium model supports this hypothesis.

In addition to these structural limitations, GSIM makes several assumptions that we might want to question regarding their applicability to the cereals sector of the SADC region. First is the assumption of local linearity of demand and supply functions. We note here that if the demand function is instead convex to the origin indicating diminishing marginal utility (true for the log linear form adopted in the model specification), then a linear approximation would lead to an overestimation of consumer surplus responses. Similarly for the supply function, if instead the marginal cost of production is increasing at an increasing rate (also true for the log linear form adopted here), we expect the estimated producer surplus responses to be an underestimation of the actual values. These are only marginal deviations though, since only local linearity is assumed, and both these functions are log-linear otherwise.

Second is the assumption that elasticities of export supply and substitution are constant and symmetric among trading partners. On the elasticity of supply, the symmetry of the elasticity among trading partners implies that producers in all countries are equally capable of responding price incentives. However, considering the diversity of climatic conditions and advancement of production sectors in different countries, it is clear that producers in some countries may be better positioned to respond to price incentives than others. For example, producers in a country like Botswana whose geographical and climatic conditions are restrictive may be incapable of responding to price incentive much the same way that producers in a climatically favorable environment such as Tanzania would. Similarly the degree of substitutability between local production and imports may not be uniform across imports from all countries of the region. For example, if for example the removal of tariffs causes major supply increases in both Tanzania and South Africa, we may expect South Africa imports to have a greater impact on Namibian markets than Tanzanian imports, simply due to proximity of the excess supply and the lower transportation costs, regardless of the trade relations among these countries. Since regional averages are used in this study, overall, we may expect the elasticity values employed in this study to over-estimate the degree of supply response or product substitutability for some countries of the region, and under-estimate these responses for others.

We now focus on the estimation process and the data used. The quantitative analyses described in Section 3 enable us to evaluate only the welfare effects resulting from tariff reforms, and capture neither the potential implications of concurrent trade facilitation effects – such as improved trade policy coordination and border efficiencies, nor the potential effects of reforming other non-tariff barriers. Non-tariff barriers, where they exist, would imply higher effective rates of protection in this sector, and their removal, higher price and welfare effects. We note that the cereals sector of the SADC region continues to be subject to several non-tariff barriers to trade in the form of export-import regulations, cumbersome customs documentation and clearance procedures, quality and safety standards, and phyto-sanitary requirements, as discussed in detail in section 1.3. Therefore we expect full-fledged trade reforms to have larger welfare effects than those predicted in this study.

The analyses performed in this study aggregate different types of cereals produced/consumed in the SADC region into one sector – the cereals sector. This sector aggregation, while enabling a more comprehensive assessment of food security effects, also masks some important intra-sectoral surplus/deficit trends for individual countries in the region. Consider the case of South Africa: although this country has managed to produce more than its domestic requirements in maize, it produces only 45% of its wheat requirements, and imports most of its rice (FAOSTAT, 2005). Therefore although at sector level South Africa is a net seller, it is a net buyer of specific commodities on a sub sector level. The implications of aggregation are that (1) the food security and income effects of higher prices would differ significantly among specific commodities in the sector, and (2) the expected sectoral average changes in prices may differ from the actual individual commodity price responses.

Finally, because the GSIM analysis is based on observed trade volumes, it can only capture responses originating from countries already experiencing positive trade with each other, but fails to capture 'new trade' that may result from tariff reforms for those countries currently not trading with each other due to restrictive tariff rates. The implication of this is that predicted trade responses underestimate the responses that would actually occur once tariff reforms are complete. To address this problem a small trade value of US$1 was recorded instead of a value of US$0 for countries that showed no signs of trading with other, to enable a positive trade response in cases where price incentives are large enough[17].

7. Conclusion

As the SADC policy maker struggle with the issue of recurrent food shortages and persistent chronic food insecurity for the vulnerable poor populations, scholars and policy advisers turn to regional trade as a critical component of a comprehensive food strategy, emphasizing that: 'Regional free trade agreements, as facilitated through … the SADC Protocol on Trade, can help SADC countries achieve national food security through

[17] One might argue though that for two countries that never traded with other over the four-year period of study (1999-2002), despite season and policy induced price fluctuations, tariff reform induced price changes would have to be rather large to reverse this trend.

regional trade integration.' Mano et al 2003. This study was a step towards bringing quantitative evidence to the trade-food security policy debate. Using the GSIM model, in an analysis of the food grain sectors of thirteen of the fourteen SADC countries, the study evaluated the welfare effects of tariff reforms in the cereals sector of the SADC region. The study sought to answer the following questions:

(1) Does openness increase aggregate supply of cereals, available at lower prices to consumers?

(2) Does openness improve regional wealth, through higher surplus for producers of grains, and/or increased buying power for consumer?

(3) Does tariff reform reduce extra-regional exports and curb cross-hauling?

(4) Does increased openness increase vulnerability of regional countries to external price/supply shock?

Results from the analysis suggest that at the *regional level*, all else being constant, freer intra-regional trade has the effect of increasing aggregate supply of cereals very minimally, and the average price of food is expected to drop slightly. The removal of tariffs increases mobility of grains in the region, though in such as manner that the new equilibrium prices are not remarkably different from original prices for most countries. Intra-SADC trade increases, whereas trade with the world generally decreases, indicating diversion of trade from the rest of the world to the region. Cross-hauling is however expected to increase with intra-regional tariff reforms, suggesting that this phenomenon is possibly a result of response to cross-border surplus/deficit and price incentives among geographically close regions within neighboring countries, rather than countries trying to avoid high tariff barriers[18]. In case of intra-regional supply shocks, higher price and welfare responses are expected under freer markets for countries of the region other than the source of the shock (the country experiencing the shock is better able to cope), though only slightly different from what would be expected in the absence of tariff reforms. The question of whether or not increased regional integration reduces (on the margin) individual countries' vulnerability to external supply shock appears inconclusive, with country responses depending on pre- and post-reform trade relation with the rest of the world. Net welfare effects are small and negative, implying lower regional income. These results are robust to changes in elasticities of supply and substitution, in terms of

[18] Regional tariff reforms thus enables countries in which both deficit and surplus regions exist to import and export the same commodity, by taking advantage of geographic proximity to deficit or surplus regions in neighboring countries.

expected direction of change. Engaging in indiscriminate tariff reforms on all imports is expected to produce larger, more positive welfare effects. Aggregate supply is also expected to increase substantially and prices to drop by a comparable magnitude, while trade with both the region and the world increases. Overall we can conclude that intra-regional tariff elimination per se, is not a sufficient policy option in inducing greater regional supply of cereals available at lower prices to consumers. Autonomous MNF tariff reforms seem to be a better policy option in attaining this objective.

References:

Anderson, J.E., J.P. Neary, 'A New Approach to Evaluating Trade Policy.' *The Review of Economic Studies*, 63(1), 1996.

Arlindo, P. and Tschirley, D. *'Regional Trade in Maize in Southern Africa: Examining the Experience of Northern Mozambique and Malawi*.' Policy Synthesis for Cooperating USAID Offices and Country Missions, Number 67, 2003.

Armington, P.S. 'A Theory of Demand for Products Distinguished by Place of Production.' *International Monetary Fund Staff Papers*, 16(1) pp 159-179, 1969

Arrow, K., and Hahn, F. 1971. *General Competitive Analysis*. San Francisco - Holden-Day.

Chau, N.H, Fare, R., Grosskopf, S. 'Trade Restrictiveness and Efficiency.' *International Economic Review* 44(3): 1079-1095, 2003.

Chauvin, S., Gaulier, G. *'Regional Trade Integration in Southern Africa'*. CEPII No. 2002-12, 2002.

Debreu, G. 1959. *Theory of Value*. New York - Wiley.

de Melo, J., 'Computable General Equilibrium Models for Trade Policy Analysis in Developing Countries: A Survey'. *Journal of Policy Modeling* Vol. 10, pp469-503, 1988.

de Melo, J., Robinson, S. 'Product Differentiation and The Treatment of Foreign Trade in Computable General Equilibrium Models of Small Economies.' *Journal of International Economics*, Vol. 27:47-67, 1989.

DeRosa, D.A., *'International Trade, Regional Integration and Food Security in the Middle East'*. IFPRI TMD Discussion Paper No. 3, 1995

Dervis, K., J. de Melo and S. Robinson, *General Equilibrium Models for Development Policy*. Cambridge University Press, 1982.

Devarajan, S., D. Rodrik. 'Pro-Competitive Effects of Trade Reform: Results from a CGE Model of Cameroon.' *European Economic Review* 35, July 1991.

Devarajan, S., J.D. Go, J.D. Lewis, S. Robinson, P. Sinko. 'Simple General Equilibrium Modeling.' In Francois, J.F. and Reinert, K.A. (eds), *Applied Methods for Trade Policy Analysis: A Handbook.* Cambridge University Press, 1997.

Dixon, P.B., B.R. Parmenter, J. Sutton and D.P. Vincent, '*A Multi-sectoral Model of the Australian Economy*.' Monach University, 1982.

East African Community '*Regional Maize Trade Policy*.' Status Report, 2004.

Food Early Warning System Network (FEW NET) and World Food Program (WFP). '*Informal Cross Border Food Trade in Southern Africa*'. Issues 1- 9, 2004-2005.

Food and Agriculture Organization (FAO), 'FAOSTAT data', 2004.

Francois, J.F.; Hall, H.K. '*Global Simulation Analysis of Industry-Level Trade Policy*.' Tinbergen Institute, CEPR, US Commerce Department, 2003.

Francois, J.F. and Reinert, K.A. (eds), *Applied Methods for Trade Policy Analysis: A Handbook.* Cambridge University Press, 1997.

Francois, J.F.; Hall, H.K. 'Partial Equilibrium Modeling.' in Francois, J.F. and Reinert, K.A. (eds), *Applied Methods for Trade Policy Analysis: A Handbook.* Cambridge University Press, 1997.

Gibson, K.L. '*Armington Elasticities for South Africa: Long- and Short-Run Industry Level Estimates.'* TIPS Working Paper 12-2003, 2003.

Grossman, G.M., Helpman, E., "Technology and Trade", in *'Handbook of International Economics Vol. 3'*. Elsevier Science B.V., 1995.

Harberger, A.C. 'The Incidence of the Corporation Income Tax.' *Journal of Political Economy* 70(3), 1962.

Heckscher, E., Ohlin, B. *'Heckscher-Ohlin Trade Theory'*. ed Flam, H., and Flanders, M.J., Cambridge MIT Press, 1991.

Helpman, E., Krugman, P., *'Market Structure and Foreign Trade.*' MIT Press, 1985.

Hertel, T. *Applied General Equilibrium Analysis of Agricultural and Resource Policies.'* Purdue University, Department of Agricultural Economics, Staff Paper No. 99-2, 1999.

Hertel, T. *Global Trade Analysis: Modeling and Applications*. Cambridge University Press, 1997.

Hoekman, B. and Schiff, M. 'Benefiting from Regional Integration.' Chapter 55 in Hoekman, Mottoo and English eds. *Developing Countries and the WTO: A Handbook*, World Bank. 2002.

Holzner, M. 2004. *GSIM Measurement of the Costs of Protection in Southeast European Countries*. The Vienna Institute for International Economic Studies (wiiw).

Ianchovichina, E., Nicita, A., Soloaga, I. *Trade Reform and Household Welfare : The Case of Mexico.* World Bank, DECRG-Trade, 2001.

Jachia, L. and E. Teljeur, 'Free Trade Between South Africa and the European Union: A Quantitative Analysis.' *UNCTAD Discussion Paper* No. 141, 1999.

Jayne, T.S., B. Zulu, D. Mather, E. Mghenyi, E. Chirwa, and D. Tschirley. *Maize Marketing and Trade Policy in a Pro-Poor Agricultural Growth Strategy: Insights from Household Surveys in Eastern and Southern Africa.* Draft, 2005.

Jayne, T., Y.Khatri, C.Thirtle, T.Reardon. 'Determinants of Productivity Change using a profit function: smallholder agriculture in Zimbabwe.' *American Journal of Agricultural Economics* 76(3) 1994

Jayne, T., M. Hajek, J. van Zyl. 'An Analysis of Maize Marketing Policies in South Africa.' *MSU International Development Working Paper No. 50* 1995.

Jere, G. '*Trade Policies and Agricultural Trade in the SADC Region: Policies and Implications'*. Zambia Case Study, FANRPAN, 2002.

Johansen, L. '*A Multi-sectoral Study of Economic Growth*.' Amsterdam-1960, Published by American Elsevier, 1974.

Jones, R.W. 'Trade with Non-Traded Goods: The Anatomy of Interconnected Markets.' *Economica*, Vol 41, pp121-138, 1974.

Jones, R.W. 'The Structure of Simple General Equilibrium Models.' *Journal of Political Economy* 73(6) 1965

Kahuika, S.T. '*Trade Policies and Agricultural Trade in the SADC Region: Policies and Implications'*. Namibia Case Study, FANRPAN, 2002

Kydd, J., A. Dorward, J. Morrison, and G. Cadisch. 'Agricultural Development and Pro-Poor Economic Growth in Sub-Saharan Africa.' *Oxford Development Studies* 32(1) 2004

Laird, S. 'Quantifying Commercial Policies.' in Francois, J.F.; Reinert, K.A. (eds), *Applied Methods for Trade Policy Analysis: A Handbook.* Cambridge University Press, 1997.

Leamer, E.L., Levinsohn, J., "International Trade Theory: The Evidence", in *'Handbook of International Economics Vol. 3'*. Elsevier Science B.V., 1995.

Leontief, W. 1953. "Domestic Production and Foreign Trade: The American Capital Position Re-examined," *Proceedings of the American Philosophical Society, 97*, September, 332-349. Reprinted in *Readings in International Economics,* edited by Richard Caves and Harry. G. Johnson, Homewood, IL: Irwin, 1968.

Lewis, J.D., Robinson, S., Thierfelder, K., 'Free Trade Agreements and the SADC Economies'. *Journal of African Economies* Vol 12. 2003.

Lewis, J.D. '*Reform and Opportunity: The Changing Role and Patterns of Trade in South Africa and SADC*.' A Synthesis of World Bank Research. 2001.

Luo, R.H., Y. Liub and Y. Zhang. 2004. *Impact of Trade Liberalisation between Greater China and New Zealand*, Department of Economics, Auckland University of Technology, Auckland, New Zealand.

Madola, M.V., Msiska, F., Chiputula, R. '*Trade Policies and Agricultural Trade in the SADC Region: Policies and Implications'*. Malawi Case Study, FANRPAN, 2002

Mafusire, A., *'SADC Trade: Challenges and Opportunities'*. TIPS Annual Forum, 2002.

Mano, R., Isaacson, B., Dardel, P. *'Identifying Policy Determinants of Food Security Response and Recovery in the SADC Region: The Case of the 2002 Food Emergency.'* FANRPAN Policy Paper, 2003.

Mano, R. *'The Food Security Situation in the SADC Region: Policy Dimensions and scope for recovery.'* FANRPAN Policy Discussion Paper, 1(1) 2003.

Martin, W. 'Measuring Welfare Changes with Distortions.' in Francois, J.F.; Reinert, K.A. (eds), *Applied Methods for Trade Policy Analysis: A Handbook.* Cambridge University Press, 1997.

MasColell, A., Whinston, M.D., Green, J.R., *'Microeconomic Theory'*. Oxford University Press. 1995.

Masters, W.A., Hertel, T., Elbehri, A. 'The Uruguay Round and Africa: a Global, General Equilibrium Analysis.' *Journal of African Economies*, 7(2): 203-234, 1998.

Masters, W.A, and Winter-Nelson, A., *'Measuring the Comparative Advantage of Agricultural Activities: Domestic Resource Costs and Social Cost-Benefit Ratio'*. American Journal of Agricultural Economics, Vol. 77, May 1995, pp243-250

McCulloch, N., PRMTR and Institute of Development Studies, Sussex. *The Impact of Structural Reforms on Poverty: a Simple Methodology with Extensions*. PREM Trade, World Bank, 2002.

McCulloch, N., Winters, A.L., Cirera, X. *Trade Liberalization and Poverty: A Handbook. Center for Economic Policy Research,* DFID, 2001.

McDonald, S., J. Kirsten, '*South African Agriculture and World Market Changes*', Department of Agricultural Economics, University of Pretoria. 37th Annual Conference of the Agricultural Economics Association of South Africa, 1999.

Moepeng, P. '*Food Security, Agricultural Policy and Environmental Interface: An African Perspective.*' The case of Botswana, BIDPA, 2003.

Mudungwe, N. *'The Level and Variation of Tariff Rates: A Comparative Analysis of Zimbabwe and South Africa Tariff Regimes*.' TIPS Annual Conference, 2002.

Mukerjee, N., Robinson, S., *'Southern Africa: Economic Structure, Trade and Regional Integration'*. TDD Discussion Paper No. 5, IFPRI 1996.

Poonyth, D., Esterhuizen, D., Ngqangweni, S., Kirsten, J.F. '*Trade Policies and Agricultural Trade in the SADC Region: Policies and Implications'*. South Africa Case Study, FANRPAN, 2002

Pyatt, G., 'A SAM Approach to Modeling'. *Journal of Policy Modeling* Vol. 10, pp469-503, 1988.

Robinson, S., Roland-Holst, D.W., 'Macroeconomic Structure and Computable General Equilibrium Models'. *Journal of Policy Modeling* Vol. 10, pp469-503, 1988.

Roningen, V.O. 'Multi-Market, Multi-Region Partial Equilibrium Modeling.' In Francois, J.F.; Reinert, K.A. (eds), *Applied Methods for Trade Policy Analysis: A Handbook.* Cambridge University Press, 1997.

Roningen, V.O., J. Sullivan, and P.M. Dixit, *Documentation of the Static World Policy Simulation (SWOPSIM) Modeling Framework*, Staff Report AGES 9151, U.S. Department of Agricultural, Economic Research Service, September 1991.

SADC Food Security Network. *Ministerial Brief*, 2003

SADC Food, Agriculture and Natural Resources '*Food Security Early Warning System Monthly Updates*.' 1996 – 2006.

Scarf, H.E. 'On the Computation of Equilibrium Prices.' in *Ten Economic Studies in the Tradition of Irving Fisher*, W.J. Fellner (ed), Willey, 1967.

Shoven, J.B., Whalley, J. 'Applied General-Equilibrium Models of Taxation and International Trade: An Introduction and Survey.' *Journal of Economic Literature,* Volume 22, pp1007-1051, 1984.

Stern, R. '*Price Elasticities in International Trade*.' Macmillan, London. 1978.

Swan, T.W. 'Economic Control in a Dependent Economy.' *The Economic Record*, March 1960.

Thierfelder, K., Robinson, S. 'Trade and Tradability: Exports, Imports, and Factor Markets in the Salter-Swan Model.' *TMD Discussion Paper* No. 93, IFPRI, 2002.

Tschirley, D., J. Nijhoff, P. Arlindo, B. Mwinga, M.T. Weber, and T.S. Jayne. 'Anticipating and Responding to Drought Emergencies in Southern Africa'. *NEPAD Regional Conference*, 2004.

Tsikata, Y.M. *'South Africa: Trade, Liberalization and Implications for a Free Trade Area.'* Paper presented at TIPS Annual Forum, 1999.

United Nations Conference on Trade and Development (UNCTAD), Trade Analysis and Information System (TRAINS) database, 2004.

US International Trade Commission (USITC), Office of Economic Research, Note No. 2004-01-A, 2004.

Vanzetti, D., S.F. de Córdoba, V. Chau. *Banana Split: How EU Policies Divide Global Producers*. Trade Analysis Branch, UNCTAD. Draft 8 September 2004.

Vanzetti, D., B. Graham, *Simulating Agricultural Policy Reform with ATPSM*. European Trade Study Group Fourth Annual Conference. 2002.

Weber, T., J. Staatz, J. Holtzman, E. Crawford, R. Bernsten 'Informing Food Security Decisions in Africa.' *American Journal of Agricultural Economics* 70(5) 1988.

Whalley, J. *Trade Liberalization among Major World Trading Areas*. Cambridge, MIT Press, 1985.

Wobst, P. '*The Impact of Domestic and Global Trade Liberalization on Five Southern African Countries*.' TMD Discussion Paper No. 92, IFPRI, 2002.
World Bank, '*World Development Indicators'*, 2005.
World Bank, 'Removing Obstacles to Economic Growth in Mozambique.' *Mozambique Diagnostic Trade Integration Study*, Volume 2 – Main Report, December 2004.
World Bank, '*Regional Trade*.' Malawi Diagnostic Trade Integration Study, Volume 2 – Draft, December 2002.
World Integrated Trade Solution (WITS), World Bank trade database, 2005.
World Trade Organization, *Member and Observer Documents:* Trade statistics, WTO Commitments, Disputes, Trade Policy Reviews, and Notifications, 1994 to 2006 www.wto.org
Yeats, A.J. *'What Can Be Expected from African Regional Trade Arrangements*?' International Trade Division, World Bank, 1998.

APPENDIX 1: Some Basic Applied Trade Policy Analysis Models

A Perfect-Substitutes Partial Equilibrium Model:

The linearized perfect substitute model for the import sectors specifies the following functions:

Domestic demand: $D = \text{In}(q^d(p)) = k^d + \eta \text{ In}(p)$

Domestic supply: $S = \text{In}(q^s(p)) = k^s + \varepsilon \text{ In}(p)$

Import demand: $M^D = \text{In}(m^d(p)) = k^{md} + \acute{\eta} \text{ In}(p)$,

where $m^d(p) = q^d(p) - q^s(p)$

Import supply: $M^S = \text{In}(m^s(p^w)) = m^s(p^w) = k^{ms} + \acute{\varepsilon} \text{ In}(p^w) - \acute{\varepsilon} \text{ In}(1 + t + \omega)$

where $p^w(1 + t + \omega) = p$

where t represents a tariff tax, and ω represents non-tariff tax, the k's are constants, p^w is the world price, and η, $\acute{\eta}$, ε and $\acute{\varepsilon}$ are elasticities for demand, supply, import demand and import supply respectively. Equilibrium prices and quantities are then obtained by solving the system of equations for the equilibrium price, and the associated producer and consumer surpluses can be deduced. Welfare gains from exchange or policy change are measured through the evaluation of the Marshallian aggregate surplus. Policy related welfare effects can be evaluated by calculating the changes in aggregate surplus resulting from specific changes in t and ω; new equilibrium prices, production and consumption levels can also be derived. Linearizing the model through log transformations simplifies the estimation of equilibrium values, however, this kind of simplification can significantly bias results due to linearization error, especially for policy shifts that may cause large responses (Francois and Hall, 1997).

The Salter-Swam Model:

The Salter and Swan model measures aggregate social welfare either to ascertain if an economic system performs well in maximizing social objectives, such as internal balance, external balance and internal price stability, or to evaluate if in fact the social objectives can be achieved through available institutions. The model defines a simplified economic system, represented in terms of aggregate volume of domestic production (Q^s), aggregate volume of domestic demand (Q^d), import surplus ($J = Q^d - Q^s$), average internal price level (P), average external price level (R), average money wage level (W), and average real wage level (V), where the following identities hold:

(1) $Q^d = Q^s + J$,

(2) $Q^s = f(Q^d, R/W)$,

(3) $J = g(Q^d, R/W)$, and

(4) $P = h(Q^d, R, W)$.

Domestic resources and terms of trade are taken as given. Within this framework, the structure of the economy determines the required volumes of demand, the money and real wage levels, and the external price levels that would achieve pre-specified objectives. The Salter Swan model has since been developed to handle factor market linkages (Jones, 1965), non-traded goods (Jones 1974), static and dynamic input-output accounts (Dervis, de Melo, Robinson, 1982), social accounting matrices (deMelo, Robinson, 1989) and factor markets and semi-traded goods (Thierfelder and Robinson, 2002). These models have come to be known as computable general equilibrium models.

The basic CGE model, described by Devajan et al 1997 as the 1-2-3 model for one country with two production sectors and three goods, is briefly discussed. The production sectors are normally classified as the tradable and non-tradable goods sectors, and the goods as the exports, imports and domestic goods. An export good is defined as a good produced only for the export market, and is not demanded domestically, an import good is a good imported but not produced locally, and a domestic good is produced and sold only locally. The model allows three types of market participants: producers, households and the rest of the world; and uses data on external trade (imports, exports and world prices) and domestic trade (production, consumption and domestic prices) to estimates the welfare effects of alternative trade policies. The model assumes: (1) imperfect substitution of domestic goods for imports, (2) concave production possibility frontier (X) specified as a constant elasticity of transformation function, (3) representative consumer, who receives all the income, and (4) constant elasticity of substitution aggregate consumption function, Q^s. X is composed of exports and supply of domestic good, and is taken as fixed, which is equivalent to assuming full employment of all primary factor inputs. Q^s is made up of the goods consumed locally, imports and the domestic good, with constant substitution elasticity σ. The social maximum is thus defined as the point at which the economy is in equilibrium, where marginal rate of transformation in production equals marginal rate of substitution in consumption. These marginal rates are equal to the foreign rate of transformation in the absence of trade distortions, and efficiency is achieved.

The Basic Computable General Equilibrium Model:

Define the <u>endogenous</u> variables:

M = Import good
E = Export good
D^d = Demand for domestic good
D^s = Supply of domestic good
Q^d = Demand for composite consumer good
Q^s = Supply of composite production good
p^m = Domestic price of import good
p^e = Domestic price of export good
p^d = Domestic price of domestic good
p^q = Domestic price of composite consumer good
p^x = Domestic price of composite output
R = Exchange rate

<u>Exogenous</u> variables:

Y = Total sector income
B = Exogenous balance of trade
$p^{w,m}$ = World price of imports
$p^{w,e}$ = World price of exports
t = import tariff rate
τ = export tax rate
σ = Import substitution elasticity
Ω = Export transformation elasticity

The model defines the following functions:

(1)	$Q^s = F(M, D^d; \sigma)$	Import aggregation function
(2)	$X = G(E, D^S; \Omega)$	Export transformation function
(3)	$Q^d = Y/P^q$	Income demand function
(4)	$M/D^d = f_3(p^m, p^d)$	Import demand equation
(5)	$E/D^s = g_3(p^e, p^d)$	Export supply equation
(6)	$Y = p^x.X + R.B$	Income supply function
(7)	$p^q = f_1(p^m, p^d)$	Consumer price
(8)	$p^x = g_1(p^e, p^d)$	Producer price
(9)	$p^m = f_2(R, p^{w,m}, t)$	Import price
(10)	$p^e = g_2(R, p^{w,e}, \tau)$	Export price

The equilibrium market clearing conditions are:

(11)	$p^{w,m} M - p^{w,e} E = B$	Balance of trade constraint
(12)	$D^d - D^s = 0$	Domestic demand-supply equilibrium
(13)	$Q^d - Q^s = 0$	Aggregate demand-supply equilibrium

In equilibrium the market is characterized by:

$$\frac{\delta Q^s/\delta D^d}{\delta Q^s/\delta M} = \frac{p^d}{p^m} = \frac{\delta X/\delta D^s}{\delta X/\delta E} = \frac{p^d}{p^e}$$

<u>Sources</u>: de Melo, J., 1988. 'Computable General Equilibrium Models for Trade Policy Analysis in Developing Countries: A Survey'. *Journal of Policy Modeling*, Vol. 10.
Devarajan, S.; Go, J.D.; Lewis, J.D.; Robinson, S.; Sinko, P. 1997. 'Simple General Equilibrium Modeling.' In Francois, J.F.; Reinert, K.A. (eds), *Applied Methods for Trade Policy Analysis: A Handbook.* Cambridge University Press.

APPENDIX 2: Parameter Value Sensitivity Tests

Summary of Effects: E_x = 2.5

	welfare				other			
	Producer surplus	Consumer surplus	Tariff revenue	Net welfare effect	Change in Overall Consumer Prices	Change in Output	Producer Price for Home Good	Market Price for Home Good
	US$	US$	US$	US$	percent	percent	percent	percent
Botswana	-63771.2	1861503.9	-1895684.8	-97952.1	-2.12%	-1.0%	-0.40%	-0.40%
Malawi	-2044485.0	4293693.9	-2312192.9	-62984.0	-0.73%	-1.0%	-0.39%	-0.39%
Mozambique	451867.4	-1699.1	-458438.3	-8270.0	0.00%	0.4%	0.14%	0.14%
Namibia	170929.8	-202510.0	9073.1	-22507.1	0.39%	1.8%	0.70%	0.70%
South Africa	10135136.2	-8778794.5	185978.6	1542320.3	0.32%	0.9%	0.37%	0.37%
Swaziland	36139.4	-118150.2	-21233.0	-103243.8	0.25%	0.5%	0.19%	0.19%
Tanzania	-49949.1	860756.4	-918101.9	-107294.6	-0.10%	0.0%	-0.01%	-0.01%
Zambia	-2317000.3	4702846.0	-2481918.1	-96072.4	-1.23%	-1.8%	-0.70%	-0.70%
Zimbabwe	-3872930.1	9336212.9	-5930205.6	-466922.9	-1.19%	-1.3%	-0.51%	-0.51%
Lesotho	59958.4	-140834.5	-42651.6	-123527.7	0.16%	0.3%	0.10%	0.10%
other SADC	-739091.6	3312706.5	-3437069.9	-863454.9	-0.39%	-0.5%	-0.20%	-0.20%
ROW	-935402.9	671444.5	-356773.4	-620731.8	0.00%	0.0%	0.00%	0.00%

Summary of Effects: E_s = 10

	welfare				other			
	Producer surplus	Consumer surplus	Tariff revenue	Net welfare effect	Change in Overall Consumer Prices	Change in Output	Producer Price for Home Good	Market Price for Home Good
	US$	US$	US$	US$	percent	percent	percent	percent
Botswana	-122561.4	1926155.8	-1945055.4	-141461.0	-2.19%	-0.6%	-0.76%	-0.76%
Malawi	-6534515.9	8804813.1	-2397968.9	-127671.7	-1.50%	-1.0%	-1.25%	-1.25%
Mozambique	751525.2	-319116.6	-433393.0	-984.4	0.08%	0.2%	0.24%	0.24%
Namibia	316838.9	-406449.5	72033.2	-17577.5	0.79%	1.0%	1.30%	1.30%
South Africa	22534427.4	-19791972.7	1564618.3	4307073.0	0.71%	0.7%	0.82%	0.82%
Swaziland	120849.1	-323263.1	-18601.7	-221015.6	0.69%	0.5%	0.64%	0.64%
Tanzania	-497537.9	1293190.8	-1147141.6	-351488.7	-0.15%	-0.1%	-0.07%	-0.07%
Zambia	-6666157.7	9035531.5	-2605048.0	-235674.3	-2.36%	-1.6%	-2.02%	-2.02%
Zimbabwe	-12125206.2	17109104.3	-6464515.4	-1480617.2	-2.17%	-1.3%	-1.61%	-1.61%
Lesotho	290406.4	-502094.6	-36182.7	-247870.9	0.56%	0.4%	0.50%	0.50%
other SADC	-1349893.5	3841579.1	-4674300.0	-2182614.5	-0.46%	-0.3%	-0.37%	-0.37%
ROW	-1145065.6	585993.8	-755926.6	-1314998.3	0.00%	0.0%	0.00%	0.00%

Summary of Effects: Global unit value average tariff aggregation method x 2								
	welfare				other			
	Producer surplus	Consumer surplus	Tariff revenue	Net welfare effect	Change in Overall Consumer Prices	Change in Output	Producer Price for Home Good	Market Price for Home Good
	US$	US$	US$	US$	percent	percent	percent	percent
Botswana	-232828.8	3767807.3	-3863937.6	-328959.1	-4.14%	-1.2%	-1.45%	-1.45%
Malawi	-7410562.8	11973618.0	-4710021.3	-146966.1	-2.02%	-1.1%	-1.42%	-1.42%
Mozambique	1180789.6	-271526.1	-897772.5	11491.0	0.07%	0.3%	0.37%	0.37%
Namibia	253720.6	-319435.3	38070.8	-27644.0	0.60%	0.8%	1.05%	1.05%
South Africa	18991298.5	-16483718.7	951653.2	3459233.0	0.59%	0.6%	0.69%	0.69%
Swaziland	93577.8	-240713.1	-41381.1	-188516.4	0.51%	0.4%	0.49%	0.49%
Tanzania	488023.7	328445.1	-856797.3	-40328.6	-0.04%	0.1%	0.06%	0.06%
Zambia	-8217933.8	13025322.4	-5102824.0	-295435.3	-3.37%	-2.0%	-2.49%	-2.49%
Zimbabwe	-4308562.2	9649301.5	-5936442.9	-595703.5	-1.23%	-0.5%	-0.57%	-0.57%
Lesotho	160126.2	-302024.8	-83115.5	-225014.1	0.34%	0.2%	0.27%	0.27%
other SADC	-999306.4	3504702.8	-3483104.4	-977708.0	-0.42%	-0.2%	-0.28%	-0.28%
ROW	92605.7	-542820.3	-561490.6	-1011705.2	0.00%	0.0%	0.00%	0.00%

Summary of Effects: Simple average tariff aggregation method								
	welfare				other			
	Producer surplus	Consumer surplus	Tariff revenue	Net welfare effect	Change in Overall Consumer Prices	Change in Output	Producer Price for Home Good	Market Price for Home Good
	US$	US$	US$	US$	percent	percent	percent	percent
Botswana	-38355.7	1961410.4	-2066296.3	-143241.6	-2.22%	-0.2%	-0.24%	-0.24%
Malawi	-10320640.5	16776050.2	-6613424.8	-158015.1	-2.81%	-1.6%	-1.98%	-1.98%
Mozambique	1654178.0	-593620.9	-999934.2	60622.9	0.15%	0.4%	0.52%	0.52%
Namibia	265759.6	-360175.8	19050.4	-75365.8	0.70%	0.9%	1.10%	1.10%
South Africa	22040143.6	-19384739.0	495369.6	3150774.3	0.70%	0.6%	0.80%	0.80%
Swaziland	88085.6	-296485.7	-15217.2	-223617.3	0.63%	0.4%	0.47%	0.47%
Tanzania	670676.8	125373.5	-810001.7	-13951.5	-0.01%	0.1%	0.09%	0.09%
Zambia	-5902456.8	9250421.6	-3560105.4	-212140.6	-2.41%	-1.4%	-1.78%	-1.78%
Zimbabwe	-9510239.3	16083669.7	-7615876.1	-1042445.6	-2.04%	-1.0%	-1.26%	-1.26%
Lesotho	227973.5	-452445.3	-31521.0	-255992.7	0.50%	0.3%	0.39%	0.39%
other SADC	4460417.8	5270622.3	-10973109.8	-1242069.8	-0.62%	1.0%	1.22%	1.22%
ROW	237232.9	-940321.6	-825113.3	-1528202.0	0.00%	0.0%	0.00%	0.00%

Summary of Effects: Import weighted average tariff aggregation method								
	welfare				other			
	Producer surplus	Consumer surplus	Tariff revenue	Net welfare effect	Change in Overall Consumer Prices	Change in Output	Producer Price for Home Good	Market Price for Home Good
	US$	US$	US$	US$	percent	percent	percent	percent
Botswana	-61454.2	1419175.7	-1634850.4	-277129.0	-1.62%	-0.3%	-0.38%	-0.38%
Malawi	3586954.2	-5493566.6	-72237.4	-1978849.8	0.94%	0.5%	0.68%	0.68%
Mozambique	9473014.9	-15989773.0	4252417.5	-2264340.6	4.16%	2.4%	2.97%	2.97%
Namibia	127737.3	97033.5	-201237.2	23533.7	-0.19%	0.4%	0.53%	0.53%
South Africa	13167956.3	-10320751.9	-571438.1	2275766.3	0.37%	0.4%	0.48%	0.48%
Swaziland	80971.7	-197561.7	-13663.3	-130253.3	0.42%	0.3%	0.43%	0.43%
Tanzania	-300420.6	1086391.5	-910796.9	-124826.0	-0.13%	0.0%	-0.04%	-0.04%
Zambia	-5082320.6	7954280.6	-3159350.1	-287390.1	-2.07%	-1.2%	-1.53%	-1.53%
Zimbabwe	-668216.9	2822973.9	-4085345.9	-1930588.9	-0.36%	-0.1%	-0.09%	-0.09%
Lesotho	209717.6	-448493.5	60003.3	-178772.6	0.50%	0.3%	0.36%	0.36%
other SADC	-1042271.6	3613853.1	-3493491.6	-921910.2	-0.43%	-0.2%	-0.29%	-0.29%
ROW	-23812498.1	23489580.7	-422453.0	-745370.4	-0.01%	0.0%	-0.01%	-0.01%