IMPACT OF SOUTHERN AFRICAN FREE TRADE ZONE ON FOOD SECURITY IN BOTSWANA

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IN BOTSWANA

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CHAPTER I

INTRODUCTION

OVERVIEW

The Southern Africa Development Corporation Community (SADCC) was formed in 1980, for the primary purpose of cooperating to achieve food security and self-sufficiency at regional and national levels. These objectives were to be achieved through increases in agricultural production. Interregional trade was left out even though it is an engine towards achieving food security because none of the members of SADCC was a surplus country. Few countries were self-sufficient by then in the staple food maize, those countries were Zambia, Malawi and Zimbabwe (Mumbengegwi, 1987).

Trade results when production of a particular good in one country is replaced by imports from the one that possess comparative advantage in its production. Among cooperating partners it involves complementary in production of tradable goods. If trade was forced among the members of SADCC, misallocation of resources was going to occur as a result of trade diversion and affect welfare adversely. Another factor that could have made trade among the member states difficult is political instability in some countries. It was going to disrupt trade flows at one point, potentially threatening food security.

It is the regional political environment that brought nine countries together to form SADCC aimed at economic liberation and integrated development of national

economies. The nine member states were to bring together their efforts to reduce dependence on South Africa for food supply[1]. South Africa was excluded from SADCC because of political ideology, which was a threat to the food security in the region since it is the main supplier. Later on due to changes in the regional political environment, the focus of the organization changed and it led to the establishment of Southern African Development Community (SADC) in 1992. SADC is more focused in sustainable development in all areas for human endeavor. In 1994 South Africa also joined the organization.

The thought of regional integration came after positive changes in political environment in the region. This integration involves among others the creation of a free trade zone. SADC members signed the Free Trade Protocol in 1996 as a way to improve trade within the region which has been reported to be about 10% of the total trade (Economist, 1995). Even though, trade was not a major concern for the organization before, there are trade agreements within the SADC region for different members.[2] Other factors that could have contributed to low trade are high tariffs for non-maize cereals and other commodities, and non-tariff barriers such as high transportation costs and delays on import and exports license processing.

Under a free trade zone, members will reduce tariffs gradually to mutual trade but keeping their individual tariffs with non-members. This free trade proposal is intended for expansion of domestic production in countries that have comparative advantage and

[1] SADCC original members: Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia and Zimbabwe. SADC membership includes: Mauritius, Namibia, South Africa, Democratic Republic of Congo and Seychelles. Namibia joined SADCC in 1990 after it gained its independence.

[2] Trade agreements within SADC: Southern African Customs Union (SACU) and Common Market for Eastern and Southern Africa (COMESA).

are able to export to South Africa whose exports to SADC have been six times its imports from the region. If trade flow is only in one direction, other member states will run out of foreign exchange for imports. It is also meant to improve food security in the region.

Food security is defined as "access by all people at all times to enough food for an active and healthy life" (World Bank, 1986). Food security is a high priority for almost all countries around the world. Many governments believe it is their responsibility to ensure food availability to their people. There are a few policy options that can be pursued by governments to improve food security. These include policies that advocate increase in productivity of the arable sector and increase in trade. Achieving food security is not the only task; its sustainability also has been a major concern of the SADC region. Oshaug (1985) has argued that a society is said to be enjoying food security if it has developed internal structures that will enable it to sustain food security when faced with threatening situations.

To address the food security problem and its sustainability, SADC members have formulated policies at a regional level that have been implemented by governments of the respective member states. Despite all these efforts, the number of people in SADC countries who are food insecure continues to rise (except in South Africa). Estimates show that the number of people in SADC who are food insecure has almost doubled, from 22 million in 1979-81 to 39 million in 1990-92 (FAO, 1996).

The persisting food insecurity problem in the region is an indication that the problem has not been addressed with correct measures. For instance, in the mid 1980s the main objective of food security policies was self-sufficiency which only focused on one of the three phases of food security, production, leaving out the market- and

consumption-oriented phases (Hesselberg, 1994). The production-oriented phase is aimed at increasing productivity and production to become self-sufficient in major crops at the national level. The market-oriented phase takes into consideration production improvement as well as increases in marketed output from farmers and food imports that make food easily available at reasonable prices. The consumption phase is concerned with the ability of households to obtain sufficient nutrition through income from farming or other social benefits. According to Hesselberg (1994), good policy that is meant to improve food security has to consider all three phases.

Botswana is not an exception to the food insecurity problem even though it was recently classified as a 'middle income' developing country on the basis of its higher per capita annual income (World Bank, 1997). This indicates some progress on the macroeconomic development but it does not rule out the problem of food insecurity at the household level.

Over the years, the government of Botswana through the Ministry of Agriculture had put in place policies designed to address the food security situation. The objectives of these policies could not be achieved because they were not appropriate for the situation at that time as indicated by the 1989 sector assessment report (Sigwele, 1995). For instance, the 1985 National Food Strategy, which was aimed at a sustainable increase in food production through subsidies and price incentives to achieve food self-sufficiency, did not correctly take into account Botswana's environmental, climatic and ecological conditions (Sigwele, 1995). The soils are poor and the weather conditions are erratic which results in the arable sector being unproductive. Persistent drought periods during

the implementation of the policy, and untargeted subsidies to the agricultural sector were not helping sustainable agricultural development.

In 1988-89, after the review of the agricultural sector, a policy shift was recommended from food self-sufficiency to food security. This policy advocates trade policies for meeting food deficits. Botswana is one of those countries in the region that cannot produce enough to satisfy domestic consumption; especially maize which is the staple food. Since 1967 Botswana has not produced enough domestically to meet its consumption requirement of maize. This is due to the poor and erratic rainfall patterns that are not suitable for the production of maize. Only 20% of Botswana's total maize supply come from domestic production; the rest is imported. Other cereals, such as rice and wheat are not produced locally, and their consumption requirements are met by imports. Sorghum, on the other hand, is the main crop produced locally and is imported in small amounts during normal years. When there is an acute shortage, especially during drought years, the amounts of sorghum imported increases.

High level of dependency on imports for its cereal requirements on one hand and availability of adequate foreign exchange from diamond and beef exports on the other, makes free trade an appropriate policy for Botswana. Viability of intra-regional free trade is also increased with improved road infrastructure, which supports comparative advantage and trade. Infrastructure improvement is expected to reduce transportation costs on imports from suppliers. This would benefit Botswana because its major suppliers of maize and sorghum are with the SADC region, that is South Africa and Zimbabwe (with the former accounting for 80 percent of Botswana's maize imports). It is the interest of this study to determine how free trade in the region would affect the

cereal imports share of South Africa in Botswana. SADC member states currently have trade barriers among each other, except for countries which have a separate trade agreement. For example, SACU members which include Botswana, Lesotho, Namibia, South Africa and Swaziland. These countries trade freely, but they have import tariffs with other members of the SADC region. Tariffs on maize trade are low as compared to non-maize cereals.

To enhance food security, the Southern African region has considered implementing new policy options such as establishing a regional strategic grain reserve, a free trade zone and food import insurance program. Information on the impact of these policy options on the levels of food security, the cost-effectiveness and welfare effects for producers, consumers, and governments would be useful to policy makers. Evaluation of these policy options will also provide policy makers and implementers with information to guard against misguided policy during implementation. This study will answer the following: what is the optimal flow of cereals and the price outcomes consistent with trade between Botswana and her trading partners after implementation of free trade?

General Objective

The study aims to determine the effects of a Southern African free trade zone as a way to improve food security in Botswana.

Specific Objectives

1. Determine the optimum volume of trade in cereals (maize, wheat, and sorghum) and price outcomes for Botswana and her trading partners under the three scenarios: low, moderate, and free trade.

2. Determine the welfare impact of free trade policy by comparing the results from the three scenarios (free trade versus low and moderate trade).

Organization of the Study

This section describes the way in which the study is organized. The chapter that follows the introduction is the conceptual framework that covers the theoretical analysis of the topic (chapter II). It is then followed by the literature review as chapter III. Methodology and data sources used in this study are in chapter IV. The empirical results and conclusions are in chapter V and chapter VI summaries the thesis.

CHAPTER II

CONCEPTUAL FRAMEWORK

Trade has been identified as one of the four major issues that affect food security. The other three are governance, trends in population and production, and environment and sustainability requirements (Hesselberg, 1994). Trade influences food security indirectly through its effect on economic growth and on the growth of a particular sector. It also impacts food security directly through household income, and on the ability to import food commodities such that domestic shortfalls can be met (Hessellberg, 1994).

Trade also results in earning of foreign exchange which enables financing of food imports and it can lead to availability of a wider variety and better quality of food in greater quantities. It has been deduced from literature that countries involved in trade gain from the exchange of goods and services because at the national level tradeis the major source of foreign exchange. However, trade can be inhibited by tariffs and non-tariff barriers (quotas, sanitary or phytosanitary requirements and safety regulations). Generally, importing countries use tariffs and quantity restrictions to control the volume of trade as a way to protect domestic producers. For instance, trade flow can be stabilized by regulating exports and imports by quotas, so that countries export less if domestic production is below a predetermined level and export more if it is above this level. This way domestic consumers and producers are protected against unstable domestic prices resulting from under and over-supply of imports.

Even though producers and consumers are to be protected, trade should still occur to a certain extent between deficit and surplus areas. Economic theory posits that for arbitrage to occur, prices among competitive markets should differ by more than the cost of transportation, among time periods by more than storage cost and among forms by more than processing cost (Bressler and King, 1970). If prices differ by more than costs of arbitrage over a sustained period, the difference is attributed to trade distortions such as tariffs, import tax, export subsidies, etc. These trade distortions have a negative impact on the welfare of the economies of regions involved in trade as well as producers and consumers within the region.

A free trade zone as a form of integration would reduce or completely eliminate trade barriers. The results will be lower prices in the importing areas which benefits the consumers and worsens the producers. However, in the exporting country free trade is expected to increase domestic prices which lowers the consumer surplus while it increases the producer surplus. With free movement of commodities, food grains from surplus areas will flow to deficit areas. This is said to be trade driven by difference in autarky prices in the restricted trade (Dixit and Norman, 1980). High food prices in case of restricted trade for an importing country make it difficult for people with low purchasing power to access food, which results in food insecurity.

Trade within a region also leads to efficient allocation of production resources. International trade theory also posits that trading occurs because of varying ability and advantages of specialization. International trade compensates for the uneven geographical distribution of productive resources (Ohlin, 1933). A country will export goods that are intensive in factors that the country is abundant in. Thus, trading occurs if

purchasing goods from the other region is cheaper in money terms than producing them domestically. This arbitrage leads to complete elimination of factor-price difference (Leamer, 1995).

The theory of international trade has been categorized into two broad themes: one that is qualitative and mainly concerned with patterns of trade and one that is quantitative, and concerned with terms of trade (Dixit and Norman, 1980). The second theme is applicable to this study and the quantitative method used in this study is the Spatial Equilibrium Model that will provide equilibrium prices and quantities in each country involved in the model. It enables one to determine flow of trade, given supply and demand functions in each country. The results of the model will give prices of commodities and quantities for those countries that trading. However, analytical models have been developed to evaluate the welfare impact of agricultural policies on groups directly and indirectly involved. Thus, in determining the impact of trade, transportation cost must be taken into consideration and any manipulations on tariffs are to be reflected on cost of unit transported.

Given equilibrium prices and quantities at each market, the social welfare effect of free trade can be measured in terms of conventional consumer and producer surpluses. The welfare gain or loss is measured in terms of a change in surpluses comparing various policy scenarios.

Since tariffs widen the difference between prices in countries, free trade will reverse those effects and will result in a positive net social welfare. However, some researchers, even though they are of the opinion that free trade is the best policy for food security, also admit there is risk for those countries that rely on imports for food supply.

Newbery and Stiglitz (1981) states that trade exposes a country to output and input price uncertainty and that its impact on welfare can be negative.

The hypothesis of this study is that free trade within the SADC region will reduce prices of commodities, including food grains, and this will make food more available, increasing food security.

CHAPTURE III

LITERATURE REVIEW

Introduction

The impact of free trade is documented especially for North American Free Trade Agreement (NAFTA). This review intends to capture the welfare impact of free trade policy and its impact on food security. The review is divided into three parts. The first part presents the development of spatial equilibrium model and its applications on welfare measurement. The second part of the review presents welfare analysis of trade and the last part is on food security situation in SADC region in relation to trade.

Economic theory posits that due to arbitrage, prices between competitive markets should not differ by more than the cost of transportation, among time periods not by more than storage cost, and among forms by not more than processing cost (Bressler and King, 1970). If price differences between locations are greater than the transportation cost, then the difference is attributed to trade distortions such as tariffs, import tax and export subsidies. These trade distortions may affect negatively the welfare of the economies of regions involved in trade. Also, within a region, the impact of trade barriers on consumers and producers may be different. However, analytical models have been developed to provide information on how agricultural policy impact the welfare of groups directly and indirectly involved.

The Spatial Partial Equilibrium Model

Most of the models reviewed here are based on Takayama and Judge's agricultural trade model. Takayama and Judge (1964a,b) extended the spatial model originally developed by Samuelson (1952) and developed a spatial partial price equilibrium model. The model by Takayama and Judge determines the spatial structure of prices, production, allocation and consumption for all commodities. This model was built with linear price-dependent demand and supply functions for the agriculture sector to define an empirically oriented quasi-welfare function (Takayama and Judge, 1971). Other studies have followed the Takayama and Judge model for partial analysis of agriculture sector in various countries. However, the spatial partial equilibrium model include only a subset of the variables which are involved in the general equilibrium, which analyze the whole economy. It has been noted that problems may arise as a result of exclusion of some variables that others are dependent upon in the partial equilibrium model.

The partial equilibrium models have limitations. Just and Hueth (1979) argued that the use of partial equilibrium model tends to leave out the effects of the general equilibrium variables because the effects on the welfare of other related markets are not measured. The effects in one market may be reflected in another market and in turn feed back into the market of interest therefore, these effects need to be captured. Nevertheless, lack of information limits the use of general equilibrium at all times. This argument is supported by Just and Hueth (1979), who stated that the use of general equilibrium is limited by intractability of practically estimating responses of all prices and quantities in

an economy and in some countries, particularly less developed countries. An advantage of the partial equilibrium model is that it can be used where there is lack of data in certain variables of the general equilibrium model. But the partial equilibrium has a disadvantage of not be able to consider interaction between different sectors of the economy such as the interaction of industry and agriculture.

The sum of the consumer and producers surpluses is referred to as a classical triangle behind the demand and supply curves of a market. Most of the studies have used this classical triangle to measure the effect of policies on the welfare of groups involved. Just and Hueth (1979) studied the significance of the classical triangle as a measure of both direct and indirect effects of intervention. Their results showed that the impact of introducing a distortion in an intermediate market is reflected in the area behind the equilibrium of supply and demand curves known as the sum of consumer and producer surpluses. The change in the sum of consumer and producer surpluses due to interventions reflects a change in the sector welfare and thus, the change in the overall economy.

Some researchers have modified Takayama and Judge's traditional point representation model to enable them to capture other features of the market they are concerned with. For instance Mwanaumo, Masters and Preckel (1997) used a continuous-space model in which they were able to capture the welfare effects of partial reforms. The model provided a better analysis of the impact of liberalization because it captures changes in farm-to-market transaction as well as between the market centers.

The traditional model can be manipulated depending on the interest of the researcher. Some of the researchers added to the traditional model variables such as

storage activities, subsidies and tariffs, depending on the policy they are modeling. For instance, Kawaguchi, Suzuki and Kaiser (1997) modified Takayama and Judge's generalized spatial equilibrium model to allow for any degree of market structure from competitive to monopoly. They used a spatial imperfect equilibrium model to analyze the problem of imperfect competitive market for the Japanese milk market and the end results showed solutions for different market structures.

The market equilibrium analysis has become the most used analytical tool over the past decade as it can be noted from the increase in the number of studies that utilized either partial or general equilibrium approach. Chavas and Cox (1997) have attributed the increased reliance on trade and market mechanisms in resource allocation to the availability and relevance of market equilibrium analysis. It has been found to be important in the welfare evaluation of government interventions that have an impact on prices. However, general equilibrium model is to be considered as a proper way of evaluating welfare impacts of a particular change whereas, partial equilibrium is only the starting point of the general equilibrium where market equilibrium prices and quantities can be derived from supply and demand equations (Chavas and Fox, 1997). Also, Brannlund and Kristrom (1996) have observed that the partial equilibrium model will be a good approximation for the true general equilibrium if parameters of demand and supply functions are small in absolute values.

Welfare Analysis of Trade

A number of studies have been conducted using the sum of producer and consumer surpluses as a measure for the welfare impact of policy. This analytical tool

has enabled researchers to predict the impact of policy before and after implementation. Furthermore, it has enhanced evaluation of the spatial equilibrium conditions. Koo and Uhm (1986), for example used a quadratic-programming model to examine the impact of the distortions such as trade restrictions (customs tariffs on imports) and transportation costs between U.S. export ports and importing regions, on the U.S. wheat market. The welfare analysis was used to estimate the losses associated with U.S. wheat trade distortions that caused prices to differ between the markets. This model incorporated transportation and storage activities in shipping wheat from supplying areas to domestic and foreign importing countries. The results from their study showed that welfare losses in the U.S. can be largely attributed to increases in transportation costs than to tariffs. It was noted that changes in freight rate influence the wheat price in the U.S. and more of its impact is borne by producers. It can be concluded from this study that trade restrictions are not the only source of price uncertainty, but volatility in freight rates also contributes to price instability.

Some of the models used to measure the welfare impacts do take into consideration the competitiveness of the market but some do not take into account for markets in the future, despite the fact that they explicitly consider time. One of the studies that assumes competitive market but do not take into consideration markets in the future is by Noren (1991), who used the Takayama-Judge activity model to analysis allocation of resources and trade in Sweden. Noren's general equilibrium model utilized the basic Leontief input-output structure as a production function given linear supply and demand functions, where both prices and quantities are determined endogenously. But in Noren's study, demand and supply are given as linear functions of price and factor price

respectively. The objective of the study was to evaluate the patterns of comparative advantages between imports and domestic production. With this type of information available, a mathematical model can be formulated to maximize the sum of consumer and producer surpluses as a measure of the net social benefit. This model has been found to be consistent with theoretical economic behavior of the sectoral participants (Noren, 1991).

Noren was interested in evaluating the pattern of comparative advantage since it encourages specialization among sectors. However, the results indicated that a few commodities would be produced domestically but with increased quantities in the least-cost sectors, specialization on the other hand will lead to increasing amounts of imports in the high-cost sectors. In some sectors, increase in demand prices serves as an indication of increase in capital required for expansion but in others, a decrease is necessary to make expansion possible.

In some cases, to make a complex analysis simple, transportation cost between regions can be assumed to be equal for commodities under the study. Kawaguchi, Suzuki, and Kaiser (1997) conducted a study where they evaluated a spatial partial equilibrium model for an imperfectly competitive milk market. To do this they had to assume transportation cost to be equal for all fluids. Different degrees of market structure from competitive to monopoly were considered in this study and the imperfect competitive market was found to be the appropriate one for the milk market. The results of this followed the economic theory that, in a competitive market, large quantities will be shipped at a lower price; while under a monopoly market it will be the other way round, small quantities will be shipped at higher prices. In addition there were few

interregional milk movements under competitive and none under monopoly. It was observed that interregional milk movements could be explained by assuming an imperfectly competitive market (Kawaguchi, Suzuki, and Kaiser, 1997).

The spatial partial model can be applied in a single commodity or a multi-product market. The single commodity model assumes no substitution effect, whereas the multi-product takes into account the substitution among commodities. Cramer, Wailes, and Shui (1993) investigated the impacts of trade liberalization among major trading partners on the world rice market using a multi-product partial equilibrium. Their intention was to use a model that will recognize product differentiation and allow for substitution among rice types and qualities. This model was found to be the appropriate one for rice because of its thin and nonhomogeneous market; hence, it is influenced by trade restrictions.

To evaluate the impact of liberalization in the world rice market, the model was run under two scenarios of trade with distortion and free trade. For simplicity, the elasticity of substitution among rice types was assumed to be independent of changes in trade policy. The results indicated that trade liberalization would increase the world rice trade resulting in an increase in the world welfare. Producers in all exporting countries would benefit as a result of increase in exports. Also, the evaluation of trade liberalization among rice types showed an increase in volume of trade of high quality rice and low volume for lowest quality.

One of the trade agreements well documented is the North American Free Trade Agreement (NAFTA) between U.S., Canada and Mexico. This agreement raised many questions that stimulated researchers to carry out studies on its impact. Espana (1993) predicted the impact of a NAFTA on trade between U.S. and Mexico and investment

flows using a computable general equilibrium model. His conclusion was that the agreement would be beneficial to both countries. For instance, progress made by Mexico through its extensive economic reforms will be sustained and Mexico will benefit mostly from the agreement as measured by an increase in its GDP. The other benefit that came with NAFTA was the reallocation of resources to more competitive sectors within the countries involved in the agreement. The studies by Sigalla (1992) supported findings from Espana's study that trade leads to reallocation of resources to competitive sector that have comparative advantage on tradable products. This leads to economic growth in terms of increased output, employment and real wages.

Brown, Deardorff, and Stern (1992) also contributed to the literature on NAFTA by identifying important issues to be addressed in analyzing the impact of NAFTA. They also quantified the effects of trade conditions brought about by the agreement such as elimination of tariffs, non tariff barriers and investment barriers using a computable general equilibrium. Brown, Deardorff, and Stern (1992) pointed out that the creation of a free trade area should result in an increase of economic welfare in countries involved. Grennes and Krissorff (1993) confirmed this. They examined the effects of NAFTA on the agricultural sector alone using a partial equilibrium for three regions (U.S, Mexico and rest of the world). The results showed an increase of U.S. agricultural exports to Mexico and an increase in U.S agricultural imports from Mexico. This increase was attributed to reduction in trade barriers and the observation agrees with economic theory that trade without distortion benefits countries involved.

Pomeroy (1989) examined the theoretical and policy issues in developing economies with price distortions via tariff barriers and direct foreign investment in a

small open economy. The conclusion was that both foreign investment barriers and tariffs on intermediate and final goods have negative impacts on welfare. A free trade zone was found to be the second best on improving welfare and resources allocation. Some studies also showed that the welfare effects of trade depend on the size of the country, a small country trading with a large country will gain from trade depending on the differences in the country's endowments and consumer's preferences. For example, a study by Li (1996) has shown that free trade between the U.S. and Canada will benefit Canada whose economy is one-tenth that of the U.S.

Trade and Food Security in SADCC (now know as SADC)

As stated earlier on, the aim of SADCC since it was formed in 1980 has been to increase agricultural production with the overall objective being to achieve food security and self-sufficiency at regional and national levels. Interregional trade was not on the priority list of SADCC and the reason being that most of the member states of SADCC were unable to produce enough for their own consumption except for Zambia, Malawi and Zimbabwe (Mumbengegwi, 1987). Now that some countries within the region are self-sufficient and they do carry surplus during good years, the region is now considering interregional trade. Koester (1986) recommended this change in focus of the SADC, Mumbengegwi (1987), and Nuppenau (1993). Their studies indicated that the region has a potential for achieving food security if interregional trade is increased. Mumbengegwi pointed out that cooperation leads to specialization according to comparative advantage and increase in trade within the region in food. However, diversity among member states

in natural resources, climatic conditions, soil, and agro-ecology makes it possible to produce a wide range of crops which leads to a variety of goods being available that can be traded among the member states.

A study by Wago (1987) has shown that only 4% of total SADCC foreign trade are from within the region. This 4% is mainly from South Africa, which has dominated trade within the region. Wago has noted that with integration, the region would be able to take advantage of the economies of scale and provide greater scope for investment decisions beyond the limits of domestic markets. Integration strengthens economic bargaining power, which would result in a reduction of external dependence. Even though researchers are recommending interregional trade; they have also identified problems that would hinder it, such as high transportation costs due to lack of adequate transport networks, cumbersome customs procedures, varying balance of payment between countries, lack of information flow between producers and inequalities of income distribution (Wago, 1987).

Liberalization of both internal and external markets has been found to be important for revitalization of African economies. Therefore, many African countries have taken steps towards liberalization of markets and they have recognized the role played by market prices in providing signals for investment and consumption decisions (Pinckey, 1993). On the other hand, liberalization is thought to have brought about declines in real income and rapid fluctuations in price. Hence, domestic policies are put in place to protect producers and consumers from price fluctuations and these have been identified as trade distortions.

If these trade barriers could be removed, the regions involved will benefit. Studies by Koester (1986), Johnson (1979), and Valdes and Siamwalla (1981) made some predictions that intra-regional trade within the Southern African region would improve food security. The belief is that with free trade, stocks will always be available year round and during the years of low production at national level, hence, there is no need for national stockpiling which can be costly. This assumes that not all SADC countries are affected the same way by weather patterns. Availability of food within the region would stabilize food consumption (Valdes and Siamwalla, 1981)), which is exactly what the region would like to achieve.

Buckland (1993) examined the implications of regional trade liberalization for SADC's food security program, since trade has been identified as an important part of comprehensive structural adjustment programs. This means food security program for SADC already takes into account trade liberalization. In other words, because South Africa is included in SADC, trade liberalization would be meaningful, as the integrated region would now have a supply. The principal aims for the food security are to integrate national and regional food policies, promote increase in food and agricultural output, help eliminate periodical food crisis and develop programs aimed at raising rural incomes, generating rural employment and improve household food security (Buckland, 1993).

Among the strategies to achieve the food security objectives is the development of intraregional trade. For example, Botswana, which because of erratic weather conditions cannot be self-sufficient has changed its overall objective of the agricultural sector from food self-sufficiency to sustainable food security which advocates free trade. The study by Buckland (1993), concluded that trade liberalization will provide opportunity for

SADC's regional food security program to evolve into one that has a direct facilitative role in improving the availability and accessibility of food to households.

Nuppeneau (1993) and Pinckey (1993) examined trade between three members of the SADC region (Zambia, Malawi and Zimbabwe) in maize. These studies focused on maize because it is the common staple food in the region. Pinckey (1993) modeled the three countries as one and examined the benefits of free trade in maize focusing mainly on elements of supply stabilization. His result did not support strongly that regional free trade would stabilize maize supplies and prices. He further suggested that there could be benefits if trade is allowed across the borders between surplus and deficit areas.

Nuppenau (1993), examined how trade between the three countries would change maize quantities, prices and distribution positions taking into account the effects of drought on trade and change in import routes that might have been caused by political ideology in South Africa. He used a partial equilibrium model and his objective function was to maximize consumer surplus minus production, transportation, and stockpiling costs. He assumed producer surplus is calculated as the sub-regional prices and production levels and costs are being derived.

The results indicated that reduction in transportation cost might lead to trade between countries at a considerable volume during a normal year. His results follow economic theory that when price differs between the markets, trade will occur. In this case, trade flowed from surplus areas (with low prices) to deficit (with high prices). In other words exporting countries (Malawi and Zimbabwe) acted as price stabilizers. Nuppenau unlike Pinckey deduced from his study that if the whole region opens for maize trade, it would be better off.

Nuppenau (1993) from his study of the potential for intraregional trade between Zambia, Zimbabwe and Malawi, using a partial equilibrium model came up with an argument that trade contributes to minimal cost of procurement and distribution of food. Looking at the overall welfare of the region, countries within are better off opening their economies to trade. The researcher also, argued that during drought years trade within the region could lower the rate of price fluctuation and alleviate food shortage in the deficit areas. In the past SADC region has been concentrating in achieving food security through increase in production ignoring intra-regional trade.

In summary, this review has shown that a partial equilibrium model is mostly used to determine the welfare impact of trade policy. Many economist have developed a partial price equilibrium model using the spatial structures of prices, production, allocation and consumption to determine the degree of trade relation based on linear price dependent demand and supply functions.

Some researchers have even suggested that the use of a continuous-space model that enables capturing the welfare effects of partial reform, enhance better analysis of the influence of liberalization between the market centers. Some models, such as the quadratic-programming model by Takayama and Judge have incorporated the trade structure to simulate the production structure, marketing systems and even to help minimize transfer costs.

Studies have shown that SADC needs to increase its intraregional trade in order to enhance stability in food security, which is the main objective of the SADC cooperation. Furthermore, intraregional trade is expected to generate a steady flow of information and equality of profit (income) distribution among member states.

Finally, since the principal aim of SADC is to ensure a sustainable food security program, there is a need to encourage development, integration and good implementation of the structural adjustment program by each member state. Hence, more studies need to be conducted in such areas. Thus, the proposed study intends to contribute towards the literature on the impact of a free trade zone in a few of the SADC countries.

The studies reviewed in this research only looked at the impact of trade on about one-fourth of the Southern Africa region and also made predictions for the whole region. Examples are studies by Nuppenau (1993), Pinckey (1993) and Buckland (1993) and predictions by Koester (1986). Due to lack of data, this study will focus only on Botswana and its trading partners. This study intends to determine the impact of a free trade zone on trade flow between Botswana and its trading partners and its implication on food availability as a way to examine the impact on food security.

CHAPTER IV

PROCEDURES AND DATA SOURCES

In this study the impact of free trade zone in Botswana will be determined with respect to food security; hence, the focus will be on the arable sub-sector of agriculture. This sub-sector is more important than the livestock sector when it comes to addressing food security because it hinges mainly on the production of food crops.

To accomplish the general objective of the study an optimal volume of trade in cereals is estimated under three scenarios: low, moderate and free trade. Where low trade refers to a scenario of restricted trade; moderate trade refers to partial trade liberalization which represent the current restriction in SADC and free trade is where there is complete removal of tariffs. The impact of a free trade zone on welfare is evaluated by comparing the results from maximizing the sum of surpluses under the three scenarios. A mathematical programming approach is used to determine the optimum quantities and prices of cereals to be traded between the countries. Specifically, a multi-product spatial partial equilibrium model by Takayama and Judge (1964b) is adopted.

The countries included in this study are Botswana, South Africa, Zimbabwe, and other countries in the SADC region such as Malawi, Tanzania and Zambia. South Africa and Zimbabwe are Botswana's major trading partners in maize and sorghum. The rest of the region is included because of their potential as trading partners when a free trade zone opens borders for intra-regional trade.

The Takayama and Judge model requires demand and supply elasticities of commodities for the countries involved. These elasticities are borrowed from literature since data is not available to estimate parameters of demand and supply for this study. The elasticities are used to derive the slopes of the supply and demand curves. Also, data on other variables such as recent production and domestic consumption quantities and market prices is used in the mathematical programming formulation, as well as transportation cost between the countries. This model assumes a perfectly competitive market and ignores substitution between commodities such as maize and wheat.

Mathematical Model

To determine the optimum trade flow, the area between the linear demand and supply curves is maximized. The objective function is in a quadratic form. By maximizing this area less transportation cost, optimum equilibrium prices and quantities will be obtained. In this study, each region is a distinct market separated from the others by transportation cost. The quadratic programming method will be used to solve the following optimization problem:

The demand price-dependent function of commodity k; $D_k = (P_{jk}) = \lambda_{jk} - \sum_{h=1}^{m} \nu_{jhk} Y_{jh}$ (1)

The inverse factor supply function of commodity k; $S_k = (P_{ik}) = \theta_{ik} + \sum_{h=1}^{m} \beta_{ihk} X_{ih}$ (2)

Assume $\lambda_{jk}, V_{jhk}, \theta_{ik}, \beta_{ihk} > 0$

$$Z = \sum_{j}^{m} \sum_{k}^{n} \int_{0}^{Y_{jk}} D_k \, dY_{jk} - \sum_{i}^{m} \sum_{k}^{n} \int_{0}^{X_{ik}} S_k \, dX_{ik} \qquad (3)$$

Maximizing net social welfare.

$$Z = \sum_{j}^{n} \sum_{k}^{m} \lambda_{jk} Y_{jk} - \frac{1}{2} \sum_{j}^{n} \sum_{h}^{m} \sum_{k}^{m} \nu_{jhk} Y_{jk} Y_{jh} - \sum_{i}^{n} \sum_{k}^{m} \theta_{ik} X_{ih}$$

$$- \frac{1}{2} \sum_{i}^{n} \sum_{h}^{m} \sum_{k}^{m} \beta_{ihk} (X_{ik}) X_{ih} - \sum_{i}^{n} \sum_{j}^{n} C_{ij} XT_{ijk} \qquad (4)$$

$\sum_{j}^{n} \sum_{k}^{m} \lambda_{jk} Y_{jk} - \frac{1}{2} \sum_{j}^{n} \sum_{h}^{m} \sum_{k}^{m} V_{jhk} (Y_{jk}) Y_{jh}$ area under demand curve

$\sum_{i} \sum_{k} \theta_{ik} X_{ih} - \frac{1}{2} \sum_{i}^{n} \sum_{h}^{m} \sum_{k}^{m} V_{ihk} (X_{ik}) X_{ih}$ area under supply curve

$\sum_{i}^{n} \sum_{j}^{n} C_{ij} XT_{ijk}$ transportation cost

Subject to: $\sum_{j}^{n} XT_{ijk} - S_{ik} \leq 0$ for all j (commodity supply constraints) (5)

$\sum_{i}^{n} XT_{ijk} - D_{jk} \geq 0$ for all i (commodity demand constraints) (6)

$XT_{ijk}, X_{ik}, Y_{jk} \geq 0$ (non-negativity constraints) (7)

Variables in the model:

i, j denote the regions, j being the deficit (demand) regions and i surplus (supply) regions

h, k denote the products demanded and supplied (corn, wheat and sorghum), h, k

are elements of the total commodity set.

D_k is the regional inverse demand relation for the *k*th commodity.

λ_{jk} the intercept of the demand function of commodity k in region j.

V_{jhk} the slope coefficients of the demand function of commodity k in region j.

S_k the regional inverse factor supply relations for the *k*th commodity.

θ_{ihk} the intercept of supply function of commodity *k* in region i.

β_{ihk} the slope coefficients of the supply function of commodity k in region i.

Y_{jk} is demanded quantity of commodity k in region j (in metric tons).

X_{ik} is the supplied quantity of commodity k from region i (in metric tons).

C_{ij} is per unit transportation cost of commodity k from surplus region i to j (in U.S.$).

XT_{ijk} is the quantity of commodity k transferred from the surplus region i to region j (in metric tons).

Evaluation of Free Trade Impact

The year 1996 was chosen as a base year because it is the most recent year with almost all the data required in this study. The 1996 data represents the moderate trade scenario. For low and free trade scenarios the transportation variable is adjusted

according to the implication of the scenario. For instance; under low trade, prices will be higher in the deficit area compared to the surplus area because transportation cost, C_{ijk} has been adjusted up by tariffs rates. On the other hand; for free trade, transportation cost has been reduced by the average rate of tariffs on cereals for the respective countries.

The impact of free trade on welfare was evaluated by comparing net social welfare, consumer and producer surpluses, trade flow, optimal quantities and prices under the three scenarios (low, moderate and free trade). The welfare gains or losses were computed as changes in net social benefit.

Sensitivity analysis has been conducted to determine robustness of the results to change in elasticities. This takes into account the uncertainty of the value of elasticity that were borrowed from literature and other countries.

Data Sources

The model which is used in this study requires demand and supply elasticities of commodities for each country. Also recent data on domestic production and consumption quantities, prevailing market prices and transportation costs are required. Quantities of production and consumption, and market prices were used to derive the supply and demand functions of crops for the respective countries involved in this study. Due to lack of data, elasticities used in this study could not be estimated, instead they were borrowed from the literature. For some countries their elasticities were not available from other studies, so elasticities from other countries were applied to them.

Data on production, consumption and producer prices were obtained from FAO website. The latest data on producer prices were for 1996 and that is how the year 1996 was chosen to be the most recent. Consumer prices were not readily available at the time for most of the countries involved, which led to resorting to calibration of world market prices for cereals to come up with market prices for the respective country. Calibration involved adding average tariffs percentages on cereals for each country to world market prices. These average tariffs by each country were obtained from the World Bank (1997) annual report.

Transportation costs were obtained from Botswana Railways Department (1999) for between Botswana and South Africa. Per mileage costs between Botswana and South was obtained by dividing the unit cost (U.S.$ per metric ton) by mileage between the two countries. Then per mileage cost is multiplied by the distance between countries to get cost per metric ton. Due to lack of data, transportation cost per metric ton is assumed to be constant for commodities under this study within the SADC region. The ocean freight rates from the rest of the world was obtained from USDA web site. An average of rates from different South African ports was taken. Due to lack of data on other ports in the region South African ports were used as the main entrance. To make the ROW to be the last resort seller to SADC countries, the per unit transportation cost was raised by adding the world market price of commodities involved in the study.

CHAPTER V

EMPIRICAL RESULTS

This chapter discusses the empirical results obtained from a spatial partial equilibrium model. This model was used to determine the effects of a reduction (moderate trade scenario) as well as complete removal of trade tariffs (free trade scenario) on agricultural products, on their market prices, production and consumption quantities, trade flow and consumer and producer surpluses of cereals. The model was developed with three commodities (maize, wheat and sorghum). Their interdependencies in terms of price impacts were not considered because of unavailability of data. Attention was only paid to interdependencies between markets in production and market prices.

This chapter is organized as follows; the first part presents the net social welfare under which consumer and producer surpluses are also discussed. The next section is on market clearing quantities and prices, followed by trade flow and sensitivity analysis. In these sections the three scenarios of trade (low, moderate and free trade) are compared.

In this study the rest of the world (ROW) is involved only as a supplier of the deficit encountered by the region. Due to lack of data, exports from the SADC countries to the ROW are not considered in this study, but in real life South Africa exports to the ROW. Another assumption is that the ROW can supply whatever amount the region demands, but the region must deplete its production before considering trade with ROW. Also it is assumed that SADC countries are small and cannot influence world prices by

their actions. For simplicity, supply and demand functions of ROW are not included in the system. Individual countries can trade with the ROW directly, but in this study South African ports are used as entry points due to lack of data on other ports in the region. This could be a limiting factor for countries that are farther from South Africa because transportation cost would be high. This might lead to these countries not importing from the ROW; rather, obtaining their supply from the neighboring SADC countries which have lower transportation costs with South Africa. In real life these countries maybe better off in terms of total costs by importing from the ROW rather than the neighbouring countries within the SADC region.

Net Social Welfare Analysis

Net social welfare is the value of the objective function, defined as the sum of consumer and producer surpluses of the region minus transportation cost. The net social welfare is for six countries in the SADC region including Botswana, Malawi, South Africa, Tanzania, Zambia and Zimbabwe. Lack of data is the main reason for selecting six countries out of fourteen. The net social welfare of the three trade scenarios is compared in figure 1. The results show an increase in the net social welfare between trade scenarios to be very small, with 0.1% increase from low to moderate trade, 0.14% from moderate to free trade and 0.22 % from low to free trade. Even though the increase in net social welfare is very small, the results conform with economic theory that improvement on trade has a positive effect on net social welfare.

Economic theory states that consumers and producers can either gain or lose from the considered trade policy. The gain or loss depends on whether the country is an importer or an exporter. Consumers in the importing countries are expected to benefit with an increase in trade because as more imports enter the country, domestic prices tend to be lowered. However, this affects producers adversely. In the exporting country; producers benefit as a result of free trade, which in this model is reflected by lowering of transportation costs for exports. This is because as an exporting country moves from restricted to free trade more is being exported which leads to higher domestic prices. Therefore, the consumers in the exporting country are adversely affected.

According to appendix A, which shows market situation for cereals in each of the studied countries for the period 1987 through 1996. Within the ten year period all countries consistently have a deficit or surplus in either commodity except Zambia (maize) which in half of the years it has deficit and in the other half is surplus in maize. In Botswana consumers are expected to benefit while producers expected to lose from the free trade policy because these countries are deficit in most of the commodities. In South Africa, Tanzania, Zambia and Zimbabwe two of the studied commodities are in surplus except wheat. Therefore, in these countries, maize and sorghum producers are expected to benefit while consumers are expected to lose with free trade policy.

Figure 2 shows a comparison of the simulation welfare results between low, moderate and free trade. The results show that in Botswana, Malawi and Zambia, a move to free trade from low and moderate favors consumers while adversely affecting producers as expected. The results for South Africa, Tanzania and Zimbabwe also followed the expected outcome under all scenarios, consumers lose and producers gain.

The positive effects of surplus commodities dominated the negative effects of the deficit in wheat. Summing up consumer and producer surpluses for each country show that a move from low (restricted) and moderate (partial trade liberalization) to free trade would benefit all countries involved in this study. But with a move from low to moderate trade, some countries did not show any change in consumer and producer surpluses.

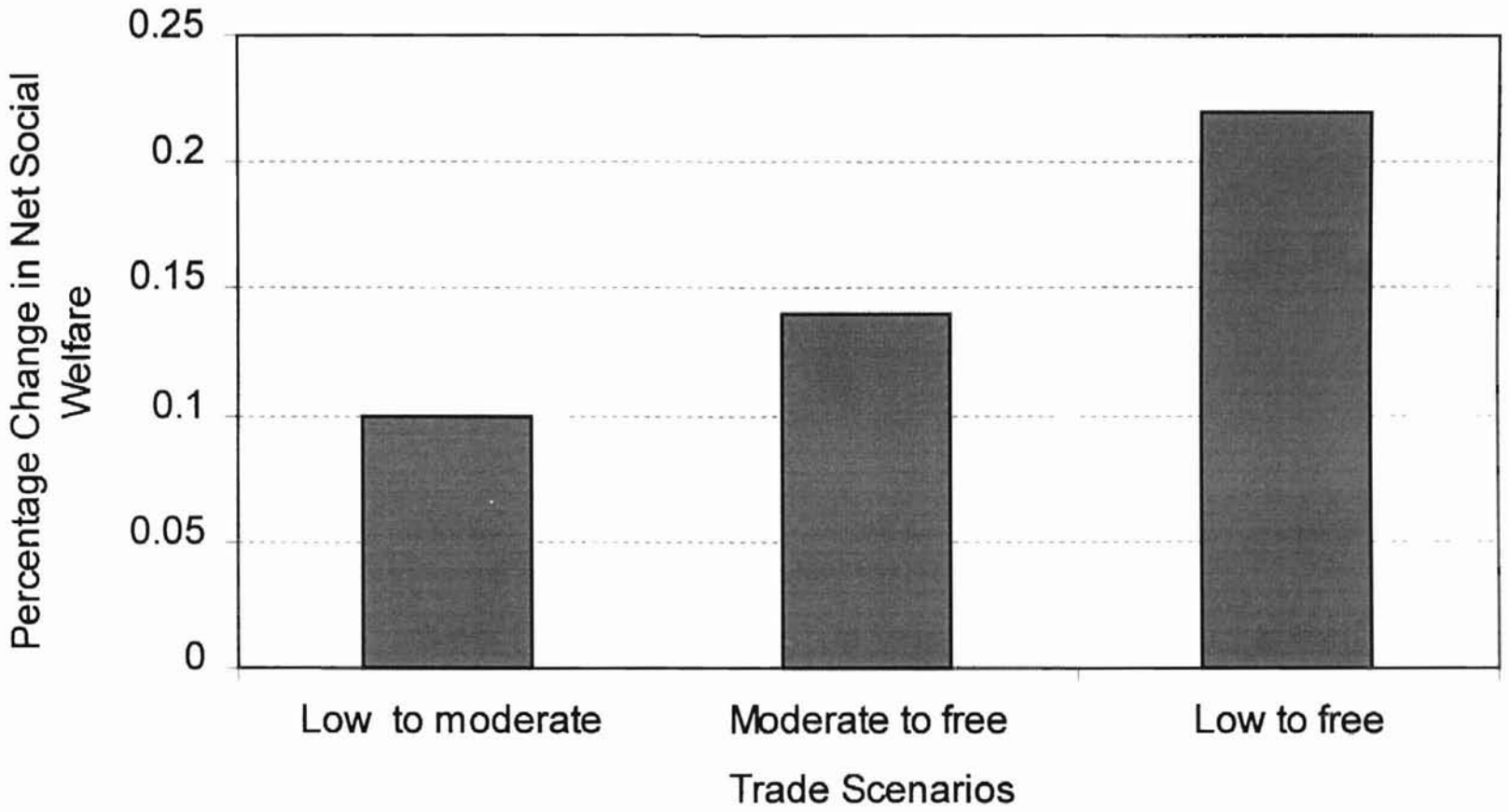

Figure 1. Percentage Change in Net Social Welfare of Six SADC Countries with Low, Moderate and Free Trade Under Baseline Elasticity.

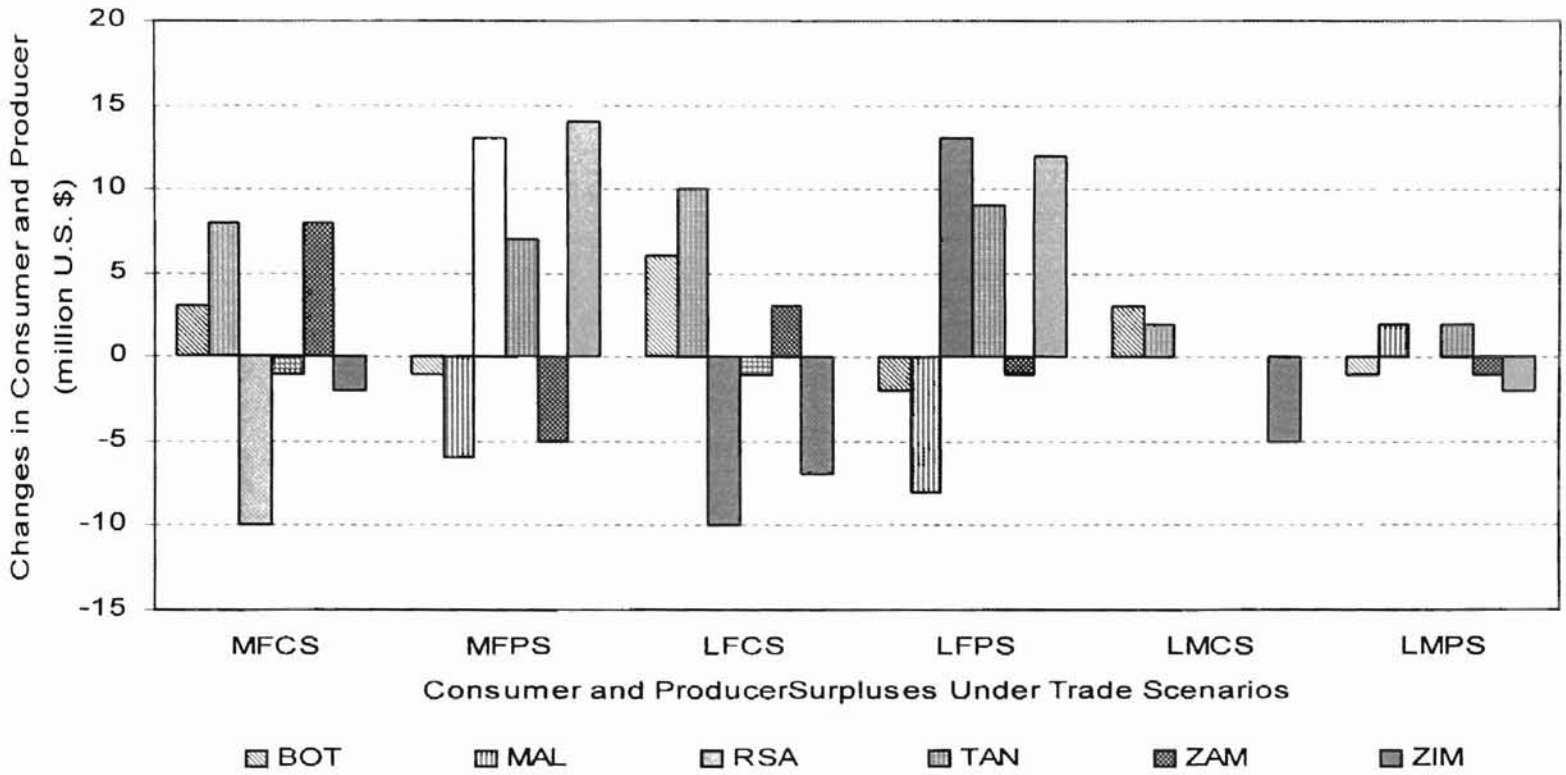

Figure 2. Changes in Consumer and Producer Surpluses Between Trade Scenarios[1].

[1] CS = Consumer Surplus, PS = Producers Surplus, MF = Moderate to Free trade, LF = Low to Free trade, LM = Low to Moderate trade. CS and PS did not change in some countries under LM.

MARKET CLEARING QUANTITIES AND PRICES

The results of this study show that Botswana is a deficit country in all commodities (maize, wheat and sorghum) under all three trade scenarios. In this study it has also been shown that under all scenarios, Botswana produces more sorghum than maize (Appendix C-1). Results under all scenarios agree with the real life status of Botswana as mentioned earlier that Botswana meets most of its consumption requirements for maize and all of wheat through imports. The results of this study imply that Botswana should provide about 67% of sorghum and 22% of maize towards its consumption requirement and the rest should come from imports.

The results of this study show Malawi and Tanzania to be self-sufficient in maize and sorghum under all scenarios. Tanzania also shows to be self-sufficient in wheat under all scenarios, which was not expected. Malawi imports about 92% of its wheat consumption requirement. For South Africa the study shows that it has surplus in maize and sorghum, and deficit in wheat under all trade scenarios, which is consistent with the existing situation. In the entire SADC region South Africa and Zimbabwe are known to be the main exporter of maize, sorghum and wheat (wheat products). In this study Zimbabwe, under all three scenarios shows to be self-sufficient in maize and sorghum. However, it shows small surplus in wheat under all the three trade scenarios. Even though South Africa shows deficit in wheat, its production shows to be the highest as compared to other countries which have surplus in wheat. Under the moderate trade scenario, the results indicate a surplus of wheat in Tanzania and Zimbabwe going to Malawi.

International trade theory states that a reduction of tariffs which in the simulation model is represented by lowering of transportation costs will lead to an increase in imports by a deficit country and therefore, it leads to an increase in exports from a surplus country. As imports increase, the increase in domestic supplies are expected to lower domestic prices, while an increase in exports is expected to lead to high domestic prices in the supplying country.

The results indicate a decrease in equilibrium prices which result from a move from low to free trade, occur in the importing countries for commodities that are traded. Where there is no trade (in self-sufficient areas) prices remain the same under all the trade scenarios, however, in Botswana prices did not change because its trade of maize and sorghum with South Africa is not affected by tariffs. The two countries are members of SACU, that is why their trade is not affected by tariffs. High prices of wheat might be attributed to the fact that individual countries maintain their separate wheat tariffs with nonmembers of a free trade zone. The results under all trade scenarios show higher prices in the deficit countries as compared to surplus areas, which is consistent with trade theory. In this study, trade flow has been from low to high price area as expected from economic theory.

TRADE FLOWS BETWEEN COUNTRIES

The results of the model under all trade scenarios show that trade flows between Botswana, South Africa and Zimbabwe. This usual trade network was expected to be broken under free trade scenario by Botswana which has deficit in all commodities

trading with other countries involved in this study. This did not happen, the results of the model show that it is efficient for Botswana to trade with South Africa and Zimbabwe as usual. Zimbabwe also trades with Malawi under all three scenarios. Tanzania and Zambia also trade with Malawi, especially in wheat. Where there is trading between countries, exports increased as you move from low to free trade (table 1), except for Botswana and South Africa, because trade between these countries is not affected by tariffs.

Zambia and Zimbabwe show surplus in wheat under all the three scenarios of trade. Furthermore; the results show that, despite their surpluses, the deficit in other countries could not be met. Surpluses in wheat of the two countries could not even meet the requirement for Malawi. The real data shows that none of these countries have surplus in wheat, so results from the model are inconsistent with real data.

Under all trade scenarios, the only countries that show as importing from the ROW are Botswana and South Africa, and the only commodity they are importing is wheat. The results show Botswana as importing wheat and supplying other countries under the three trade scenarios. The reason why these are the only countries importing from the ROW, it could be due to the restricted entry points to be South African ports. In the model transportation from ROW to SADC countries includes transportation from South Africa ports to other SADC countries. This makes it cheaper for Botswana and South Africa to import from ROW as compared to other countries that are farther away from South Africa. The results show Zimbabwe as importing wheat from Botswana (which was imported from ROW) and passes it to Malawi.

The use of South African ports was imposed by lack of data on other ports in the region. The other factor that could contribute to lack of trade between ROW and other SADC countries is shortage in foreign exchange, but it cannot be ascertained by this study because it is beyond its scope.

Table 1. Shipments Between Countries, Simulation Results for Six SADC Countries

	Maize	Wheat	Sorghum
Low Trade			
BOT.ZIM		19069.890	
RSA.BOT	62826.442		22549.160
ZAM.MAL		13706.848	
ZIM.MAL		30730.606	
ROW.BOT		69976.721	
ROW.RSA		167404.481	
Moderate			
BOT.ZIM		26601.914	
RSA.BOT	62826.442		22549.160
TAN.MAL		2747.282	
ZAM.MAL		14838.710	
ZIM.MAL		40517.062	
ROW.BOT		77508.745	
ROW.RSA		167404.481	
Free Trade			
BOT.ZIM		26989.562	
RSA.BOT	62826.442		22549.160
TAN.MAL		14427.387	
ZAM.MAL		15404.641	
ZIM.MAL		42031.850	
ROW.BOT		77896.393	
ROW.RSA		167404.481	

SENSITIVITY ANALYSIS

This section presents the impact results from the adjustment of supply and demand elasticities up and down by 10%. The choice of 10% is arbitrary. The adjustment is necessary because the elasticities used in this study are exogenous, and were obtained from other studies, which were carried out in other countries and vary according to sources. Also, these elasticities might have been estimated under a framework that is inconsistent with the current model. Sensitivity analysis is intended to show how robust the results are and it helps to determine the most influential elasticities (those that show significant changes in the results of the original elasticities). Elasticities in this study are used to derive parameters of the demand and supply functions, which are then used to run the trade model. The adjustment is only applied to the base period (moderate trade scenario).

Net Social Welfare.

Under each of the three trade scenarios a 10% decrease in supply and demand elasticities leads to a very low increase in net social welfare between all three trade scenarios (figure 3) as compared to a 10% increase in elasticities and baseline results. A 10% increase of both supply and demand elasticities gave almost similar as the baseline.

Economic theory states that if the demand and supply functions are inelastic, the quantity will be unresponsive to changes in price. That is, a decrease in demand or supply elasticity leads to a decrease in quantity demanded or supplied and the reverse is true for an increase in elasticities of demand and supply. The same effect of change in elasticity is expected in consumer and producer surpluses. But in this study the results

did not conform to the theory. This could be due to the fact that generally supply elasticities of cereals in African countries are low.

In comparing consumer and producer surpluses between trade scenarios under a 10% decrease in baseline elasticities, the results show small changes in most countries except for Zimbabwe's producer surplus and Zambia's consumer surplus (figure 4). Under a 10% increase, small changes on consumer and producer surpluses are observed between low and moderate trade (figure 5). The results also show positive changes in consumer and producer surpluses in most countries except in Botswana and South Africa. They both show a negative change in producer surplus. South Africa became an importer of maize under this scenario.

The inconsistency of the results to theory could be due to fact that two of the products used in this study are staple foods for the poor, and that farmers in these countries are less involved in market economy. These factors might have contributed to demand and supply calsticities being low, which could be attributed to an increase in quantities demanded and supplied under downward adjustment of elasticities, as well as an increase in consumer and producer surpluses. This suggest that whether prices are low producers will continue to produce, on the other hand, consumers will continue to buy these cereals (especially maize and sorghum) at high prices because they are staple foods in the region.

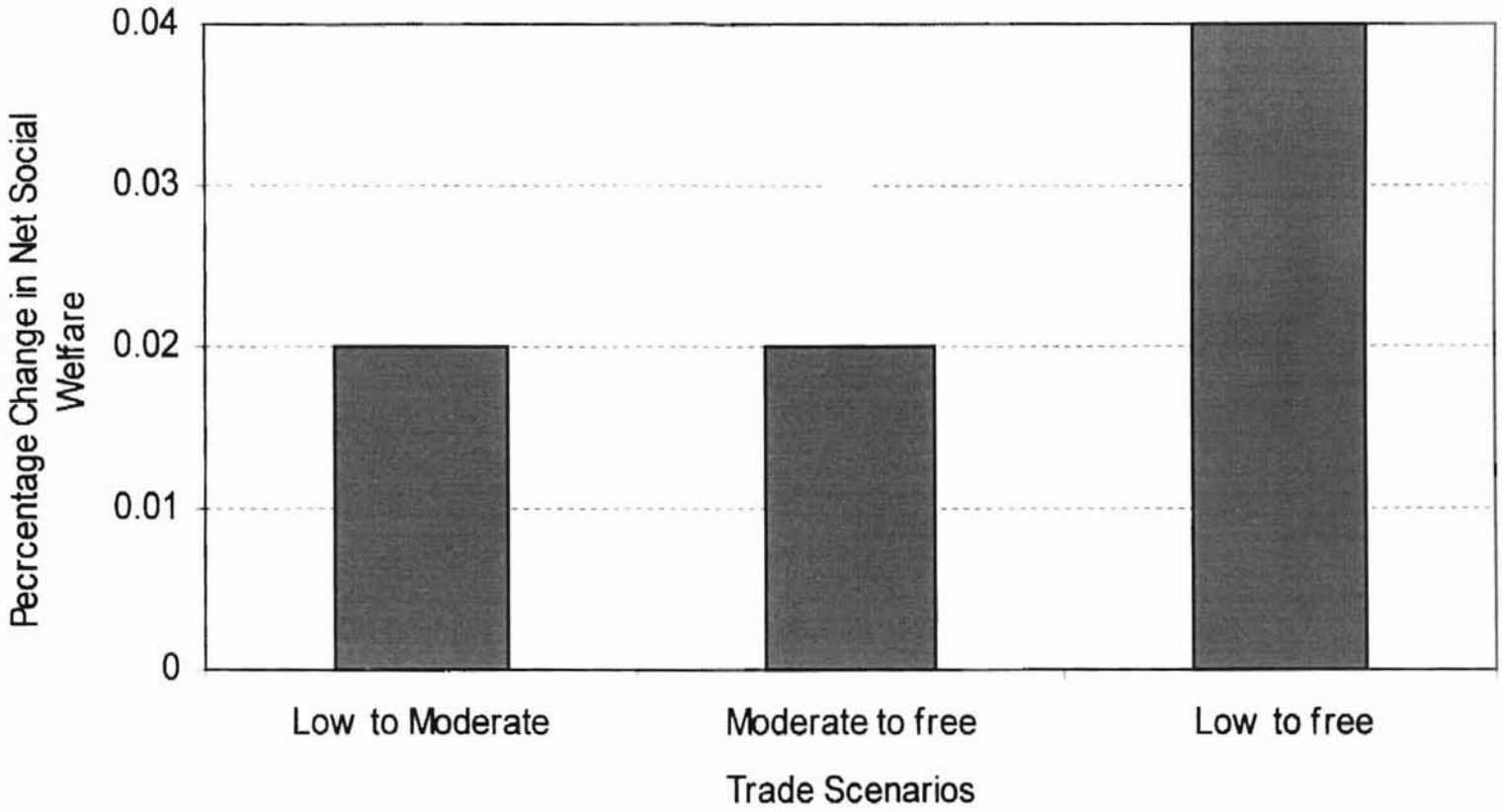

Figure 3. Percentage Change in Net Social Welfare of Six SACD Countries Between the Three Trade Scenarios, Under a 10% Decrease in Baseline Elasticities.

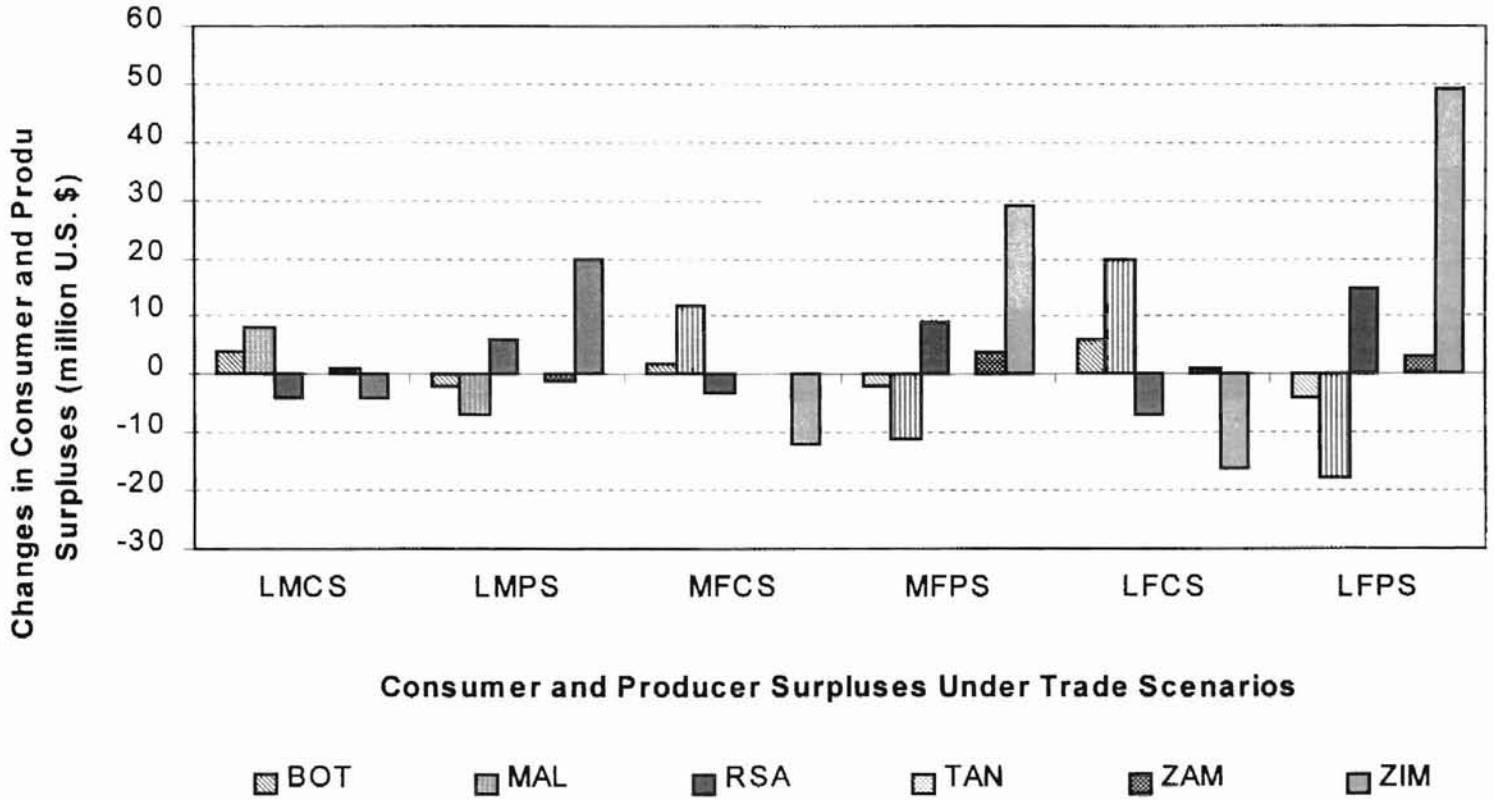

Figure 4. Changes in Consumer and Producer Surpluses Between the ThreeTrade Scenarios, Under a 10% Decrease in Baseline Elasticities.

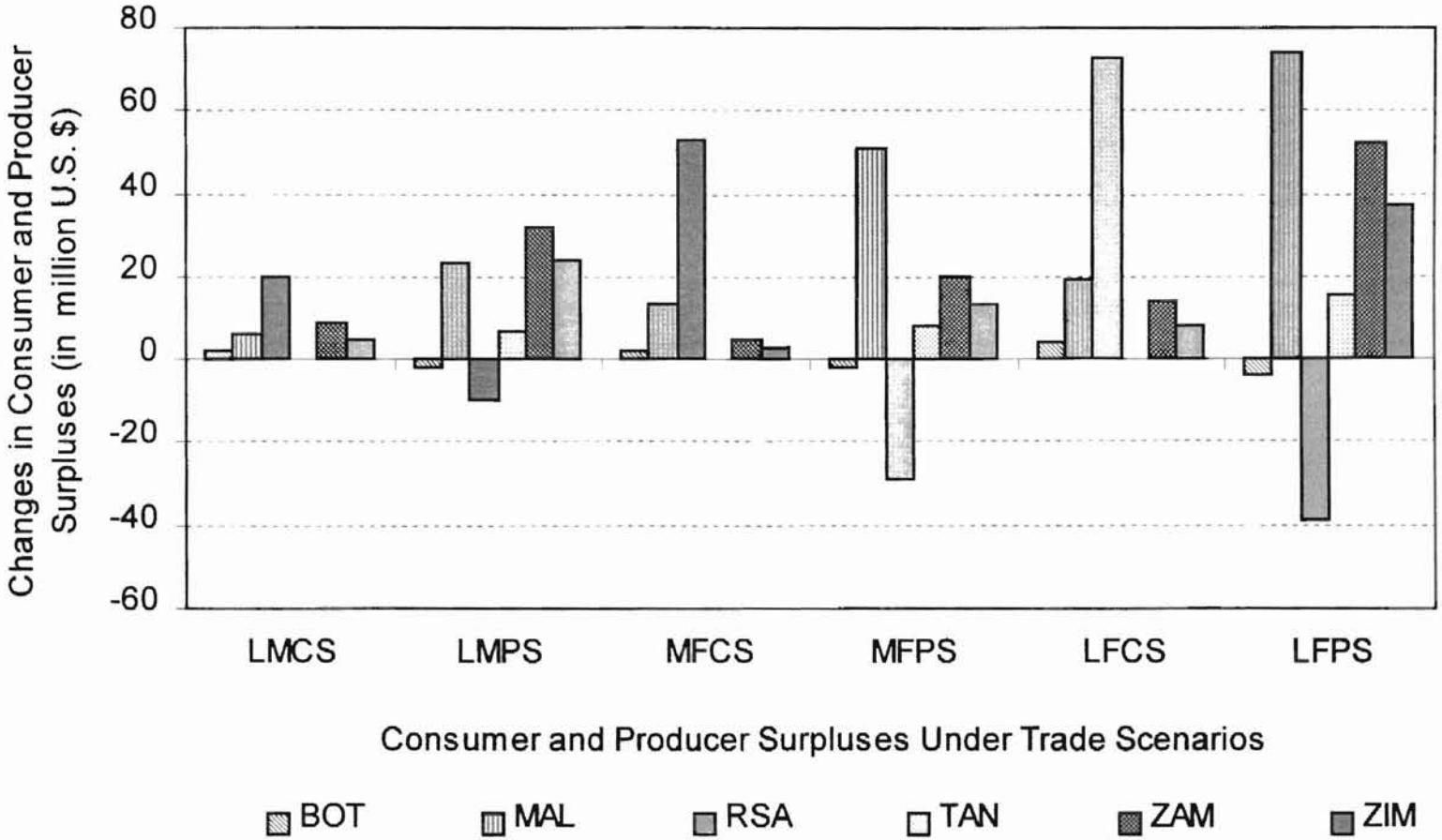

Figure 5. Changes in Consumer and Producer Surpluses Between the Three Trade Scenarios, Under 10% Increase in Baseline Elasticities.

Market Clearing Quantities and Prices.

Expectations from economic theory are that with increase in elasticity quantities are suppose to increase too and with a decrease in elasticity quantities are to decrease. The results of this study shows that under a 10% increase in both supply and demand elasticities quantities in some countries increased but not for South Africa (maize and sorghum), Zambia (maize and wheat) and Zimbabwe (sorghum supply). A decrease in quantities is observed mostly in commodities that were in surplus under the baseline results. On the other hand a 10% decrease in demand and supply elasticities results in a decrease in quantities except for South African maize and wheat (supply and demand quantities), and Zambian sorghum (supply). In other countries, for example Botswana (maize and wheat), Malawi (wheat), Zambia (wheat) and Zimbabwe (wheat and sorghum), only demand quantities took a different direction as compared to the expected decrease.

Significant changes noted in quantities after adjusting elasticities that led to either a deficit or a surplus are in South Africa, Zambia and Zimbabwe (Appendix C-3). A downward adjustment in elasticities results in South Africa still having a surplus in maize and sorghum. Zambia has deficit in wheat under downward adjustment because the quantity supplied decreased while quantity demanded increased. Zambia on the other hand, has surplus in sorghum as a result of an increase in quantity supplied. In Zimbabwe the demand and supply of maize and wheat decrease but the decrease is greater in the demand side as compared to the supply side. Therefore, both commodities are in surplus. The deficit in Malawi for maize is due to the decrease being greater in the

supply as compared to demand. In Zimbabwe the deficit in sorghum is due to the decrease in the supply while the demand is increasing.

An upward adjustment in elasticities leads to a deficit in maize and sorghum for South Africa compared to the original results. Zambia and Zimbabwe also have deficit in wheat and sorghum respectively. For South Africa and Zambia the deficit is due to a decrease in supply. Zimbabwe on the other hand, the deficit results from an increase in quantity demanded while quantity supplied is decreasing. In Malawi the surplus in maize is due to the increase in quantity supplied. Under an upward adjustment Tanzania shows as having a surplus of wheat due to an increase in supply while demand decreases.

Trade Flows between Countries.

Trade flow after adjusting elasticities up and down differs from that of the baseline results. The difference is that Tanzania shows as an exporter of wheat to Malawi, while Zimbabwe and Zambia shows to be major exporters of wheat and maize respectively. Malawi also, exports maize to South Africa since it has a deficit in maize under the same scenario. These results were observed under an increase in elasticity of supply and demand. Under a decrease in demand and supply elasticities, Zimbabwe shows as a major supplier of wheat and deficit in sorghum. For other commodities trade flow remained the same as in the original results of the baseline.

CHAPTER VI

SUMMARY, CONCLUSION AND RECOMMENDATIONS

SUMMARY AND CONCLUSION

The results of this study indicate that net social welfare improves with free trade. These findings agree with what Brown, Deardorff and Stern (1992) concluded from their analysis of the impact of NAFTA, that removal of tariffs improve the welfare. Cramer, Wailes and Shui (1993) in their study of trade liberalization on world rice market also arrived to the same conclusion.

The results of this study also show that net social welfare percentage changes between trade scenarios under an upward adjustment of demand and supply elasticities does not differ from that of the baseline results. But under a downward adjustment the percentage changes of net social welfare between trade scenarios are very small as compare to the baseline results.

The impact of moving from low and moderate to free trade is clearly reflected on consumers and producers by the simulation model. The results are consistent with the economic theory that consumers in the deficit areas benefit when moving towards free trade, while it makes producers worse off.

Under all trade scenarios the baseline results suggest that Zambia would have a surplus in wheat under all trade scenarios, which is not consistent with the actual data. Real data shows that all countries involved in this study have a deficit in wheat, which is

a know situation in the SADC region. According to the results of this study, Zambia could be an additional supplier for maize as it has been learnt from literature that it has a potential to produce more than it requires in a normal year (Mwanaumo, Masters and Preckel, 1997).

A downward adjustment in elasticities that leads to an increase in quantity supplied in most countries could be an indication that supply elasticities in these areas are lower than the original elasticities. This could be attributed to production being less dependent on market prices. This is because farmers are less involved in market economy and they also use less quantities of purchased farm inputs. Production mostly depends on climatic conditions more than any other factor. Another reason for low elasticities of maize and sorghum in these countries is that they are staple foods for the poor, so change in price has no significant effects on quantity demanded and supplied.

The original and after adjustment of elasticity results under all trade scenarios show that Botswana depends heavily on South Africa for imports of cereals. It was expected that under free trade other countries would join this trade network to lower South Africa's cereal imports share in Botswana, but this did not happen. Overall, Botswana's imports for maize and sorghum were not affected because trade between Botswana and South Africa is not affected by import tariffs or exports taxes.

In conclusion, the results of the simulation model somehow agree with prior expectations from economic theory even though percentage changes on the net social welfare are small. Any deviations from economic expectation could be attributed to data used. Data, especially consumer prices and transportation costs, from the countries

involved are difficult to obtain. Due to lack of data, a lot of calibration was done, which might have led to data used being somehow misrepresentative of reality.

Implications of Free Trade on Food Security in Botswana

The implication of these results on food security in Botswana is that, with surplus of maize and sorghum within the SADC region, Botswana would import and make food available at the national level under all trade scenarios. Of course, this will depend on the availability of foreign exchange. Comparing the trends of exports revenue and imports cost (includes other commodities) from 1993 onwards, the former has been greater than the later (World Bank, 1998). If this trend on foreign trade growth could continue, Botswana would be able to sustain food availability at the national level.

The results show that Botswana's wheat imports are from outside the region. This is an indication that if the region is faced with deficit, Botswana will still meet its requirements by importing from the rest of the world. This assures food availability at all times. On the other hand, accessibility of food cannot be assured from these results even though prices decrease with improvement in trade, because it depends also on other factors that are not considered in this study such as household income, and tastes and preferences.

Limitations and Recommendations

By using the spatial partial equilibrium model interdependence with other commodities in other sectors of the economy and effects of change in income resulting from trade are disregarded (Takayama and Judge, 1964). Therefore, it cannot be deduced from these results whether countries would afford the imports or whether it is profitable for the exporting countries to trade within the region. However, it has been pointed out in literature (Just and Hueth, 1979) that model is appropriate where data on variables used in general equilibrium analysis are not available, such as is the case here.

Further research on this topic would be necessary using actual market prices and taking into consideration interdependencies between commodities, being main staple foods for the region, their substitution effect is important to be noted. Also, if some of the assumptions made in this study can be relaxed, such as trade being allowed from SADC region to the rest of the world and the use of more than one entry port, the results may be different. It will also depend on availability of data, which was main reason why these assumptions were made. Lack of actual demand and supply elasticities for some of the SADC countries involved in this study, and lack of data on consumer prices and transportation costs was a major problem. If actual data in most of the variables was used, maybe the results could have been different.

Since the region is still at the early stages of free trade negotiations further, researches on this topic need to be done to provide information to decision makers. For instance, a general equilibrium analysis that would determine the impact of free trade on Botswana's economy would be appropriate if data availability allows. Price data needs to

be included in the SADC database. This data is one of the key variables in estimating the demand and supply function parameters which are important in elasticities

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Appendix A. Status of Cereal in the Respective Countries from 1987 to 1996

	Commodities		
Country	Maize	Wheat	Sorghum
BOT	deficit	deficit	deficit
MAL	deficit	deficit	surplus
RSA	surplus	deficit	surplus
TAN	surplus	deficit	surplus
ZAM	surplus/deficit[4]	deficit	surplus
ZIM	surplus	deficit	surplus

Source: FAO Statistical database, 1999.

BOT = Botswana, MAL = Malawi, TAN = Tanzania, RSA = South Africa,

ZAM = Zambia and ZIM = Zimbabwe.

[4] Within the 10 years period, half the period it has surplus and the other half it has deficit.

Appendix B. GAMS Model

TITLE TRADE MODEL FOR SIX OF SADC COUNTRIES

```
CROSS PRICE ELASTICITIES ARE ASSUMED TO BE ZERO IN THIS
MODEL
OBJECTIVE IS TO MAXIMIZE THE AREA BETWEEN A LINEAR DEMAND
AND A LINEAR SUPPLY.
Objective is to determine the equilibrium production and
consumption   *quantities and prices, as well as exports and
imports between the countries.
 Scenario: Moderate Trade - with ROW
=========================
$OFFUPPER OFFSYMXREF OFFSYMLIST OFFUELLIST OFFUELXREF
OPTIONS LIMROW=0, LIMCOL=0;
OPTION NLP = MINOS5;
SETS
     I REGIONS / BOT,MAL,RSA,TAN,ZAM,ZIM/
     K COMMODITY / MAIZE, WHEAT, SORG/;

     ALIAS (I,IP,J,JP),(K,KP,H,HP);

TABLE SUP(I,K) QUANTITY PRODUCED
               MAIZE          WHEAT          SORG
       BOT      23000              0         59000
       MAL    1793000           2315         75000
       RSA   10168000        2711991        549000
       TAN    2663000          84000        947000
       ZAM    1409000          60000         22600
       ZIM    2609000         280000         91000;

TABLE DEM(J,K) QUANTITY CONSUMED
               MAIZE          WHEAT          SORG
       BOT      66535          50284         56518
       MAL    1463000          68000         46000
       RSA    4274000        3023000        306000
       TAN    2330000         181000        453000
       ZAM    1180000          86000         59000
       ZIM    1349000         340000         59000  ;

TABLE S(I,K) SUPPLY FUNCTION INTERCEPTS
               MAIZE          WHEAT          SORG
       BOT   -161.33           0.00       -118.56
       MAL    -57.44         -84.97        -87.86
       RSA    -57.44        -650.94       -207.37
```

TAN	-79.44	-75.16	-126.10
ZAM	-63.52	-272.00	-111.71
ZIM	-169.89	-183.90	-92.00 ;

TABLE BETA(I,K,H) SUPPLY FUNCTION SLOPES

	MAIZE	WHEAT	SORG
BOT.MAIZE	0.01275	0	0
BOT.WHEAT	0	0	0
BOT.SORG	0	0	0.00365
MAL.MAIZE	0.000058	0	0
MAL.WHEAT	0	0.0734	0
MAL.SORG	0	0	0.00213
RSA.MAIZE	0.00002	0	0
RSA.WHEAT	0	0.00032	0
RSA.SORG	0	0	0.00058
TAN.MAIZE	0.000054	0	0
TAN.WHEAT	0	0.00179	0
TAN.SORG	0	0	0.00024
ZAM.MAIZE	0.000078	0	0
ZAM.WHEAT	0	0.0057	0
ZAM.SORG	0	0	0.00223
ZIM.MAIZE	0.00012	0	0
ZIM.WHEAT	0	0.0013	0
ZIM.SORG	0	0	0.00081 ;

TABLE D(J,K) DEMAND FUNCTION INTERCEPTS

	MAIZE	WHEAT	SORG
BOT	780.00	1157.00	628.33
MAL	866.67	1083.33	689.00
RSA	987.09	1024.00	547.71
TAN	853.67	853.67	745.33
ZAM	573.00	1040.00	912.00
ZIM	600.00	1235.00	563.33 ;

TABLE ETA(J,K,H) DEMAND FUNCTION SLOPES

	MAIZE	WHEAT	SORG
BOT.MAIZE	0.009018	0	0
BOT.WHEAT	0	0.017699	0
BOT.SORG	0	0	0.00855
MAL.MAIZE	0.000456	0	0
MAL.WHEAT	0	0.012255	0
MAL.SORG	0	0	0.01152
RSA.MAIZE	0.00019	0	0
RSA.WHEAT	0	0.000265	0

```
     RSA.SORG          0              0          0.00132
     TAN.MAIZE      0.000282          0            0
     TAN.WHEAT         0           0.003628        0
     TAN.SORG          0              0          0.00126
     ZAM.MAIZE      0.00032           0            0
     ZAM.WHEAT         0           0.0093          0
     ZAM.SORG          0              0          0.01288
     ZIM.MAIZE      0.000300          0            0
     ZIM.WHEAT         0           0.002794        0
     ZIM.SORG          0              0          0.00283 ;

TABLE C(I,J) UNIT TRANSPORTATION COST BETWEEN REGIONS
             BOT      MAL        RSA       TAN       ZAM
ZIM
     BOT      0        88         15        132        61
23
     MAL     88         0         77         71        27
27
     RSA     15        77          0        147        76
50
     TAN    132        71        147          0        80
86
     ZAM     61        27         76         80         0
18
     ZIM     23        27         50         86        18
0;

TABLE MC(J,K)  UNIT COST OF IMPORTS FROM THE REST OF THE
WORLD(FREIGHT COST PLUS WORLD PRICE)
               MAIZE    WHEAT    SORG
     BOT       214       256      181
     MAL       276       318      243
     RSA       199       241      166
     TAN       346       388      313
     ZAM       275       317      242
     ZIM       249       291      216 ;

VARIABLES  X(I,K)        QUANTITY SUPPLIED
           Y(J,K)        QUANTITY DEMANDED
           XT(I,J,K)     SHIPMENTS BETWEEN REGIONS
           ROX(I,K)      QUANTITY SHIPPED FROM REST OF THE
WORLD(ROW)
           Z  TOTAL  WELFARE
           POSITIVE VARIABLES X, XT, Y, ROX;
EQUATIONS
```

```
   OBJ              OBJECTIVE FUNCTION
   PRODC(I,K)       SUPPLY CONSTRAINT
   CONC(J,K)        DEMAND CONSTRAINT
   SUPROX(I,K)      QUANTITY SUPPLIED BY ROW BL;

OBJ..  SUM((J,K),D(J,K)*Y(J,K))- SUM((I,K),S(I,K)*X(I,K))
        - (SUM((J,K),Y(J,K)*(SUM(H,ETA(J,K,H)*Y(J,K))))/2)
        - (SUM((I,K),X(I,K)*(SUM(H,BETA(I,K,H)*X(I,K))))/2)
        - SUM((I,J,K), XT(I,J,K)*C(I,J))
        - SUM((I,K), ROX(I,K)*MC(I,K))=e=Z;

PRODC(I,K)..    SUM(J,XT(I,J,K))- X(I,K)-ROX(I,K)=L= 0;
CONC(J,K)..     SUM(I,XT(I,J,K))-Y(J,K) =G= 0;
SUPROX(I,K)..   ROX(I,K) =G= SUM(J,XT(I,J,K) -Y(J,K));
X.FX("BOT","WHEAT")=0;

MODEL MAIMOD /ALL/ ;
SOLVE MAIMOD MAXIMIZING Z USING NLP;

TABLES OF RESULTS

PARAMETER SOLUTION MARKET CLEARING PRICES AND QUANTITIES;
SOLUTION(J,K,"DEMANDED")  = Y.L(J,K);
SOLUTION(I,K,"SUPPLIED")  = X.L(I,K);
SOLUTION(J,K,"DEMPRICE")  = D(J,K)-
SUM(H,ETA(J,K,H)*Y.L(J,K));
SOLUTION(I,K,"SUPPRICE")  = S(I,K)+
SUM(H,BETA(I,K,H)*X.L(I,K));

PARAMETER SURPLUS CONSUMER AND PRODUCER SURPLUS;

SURPLUS(J,"CSURPLUS") = SUM(K, (D(J,K)*Y.L(J,K)-
(0.5*SUM(H,ETA(J,K,H)*Y.L(J,K)*Y.L(J,K))
                                - D(J,K)*Y.L(J,K)+SUM(H,
ETA(J,K,H)*Y.L(J,K)*Y.L(J,K)))));
SURPLUS(I,"PSURPLUS")  = SUM(K,
(S(I,K)*X.L(I,K)+SUM(H,BETA(I,K,H)*X.L(I,K)*X.L(I,K))
                                -
S(I,K)*X.L(I,K)+(0.5*SUM(H,BETA(I,K,H)*X.L(I,K)*X.L(I,K)))));

PARAMETER TRADE SHIPMENTS FROM ROW TO COLUMN;
TRADE(I,J,K) = XT.L(I,J,K);
DISPLAY SOLUTION, TRADE, SURPLUS;
```

Appendix C. Solutions of the Models

Appendix C-1 Market Clearing Prices and Quantities Under All Trade Scenarios

Low Trade	Quantity Demanded	Quantity Supplied	Demand Price	Supply Price
BOT.MAIZE	80042.592	17216.150	58.18	58.18**
BOT.WHEAT	50906.831		256.00	
BOT.SORG	67966.757	45417.597	47.21	47.21**
MAL.MAIZE	1797879.377	1797879.377	46.84	46.84
MAL.WHEAT	62858.425	5421.935	313.00	313.00*
MAL.SORG	56912.821	56912.821	33.36	33.36
RSA.MAIZE	4967968.910	5030795.352	43.18	43.18
RSA.WHEAT	2954716.967	2787312.486	241.00	241.00
RSA.SORG	390527.100	413076.259	32.21	32.21
TAN.MAIZE	2777113.095	2777113.095	70.52	70.52
TAN.WHEAT	171434.109	171434.109	235.00	235.00
TAN.SORG	580953.334	580953.334	13.33	13.33
ZAM.MAIZE	1599296.482	1599296.482	61.22	61.22
ZAM.WHEAT	82258.065	95964.905	281.00	281.00
ZAM.SORG	67750.496	67750.496	39.37	39.37
ZIM.MAIZE	1833071.429	1833071.429	50.08	50.08
ZIM.WHEAT	314814.305	326475.172	280.00	280.00*
ZIM.SORG	180035.714	180035.714	53.83	53.83
Moderate Trade				
BOT.MAIZE	80042.592	17216.150	58.18	58.18**
BOT.WHEAT	50906.831		256.00	
BOT.SORG	67966.757	45417.597	47.21	47.21**
MAL.MAIZE	1797879.377	1797879.377	46.84	46.84
MAL.WHEAT	63429.621	5326.567	306.00	306.00*
MAL.SORG	56912.821	56912.821	33.36	33.36
RSA.MAIZE	4967968.910	5030795.353	43.18	43.18
RSA.WHEAT	2954716.981	2787312.500	241.00	241.00
RSA.SORG	390527.099	413076.258	32.21	32.21
TAN.MAIZE	2777113.095	2777113.095	70.52	70.52
TAN.WHEAT	170526.461	173273.743	231.71	231.71
TAN.SORG	580953.333	580953.333	13.33	13.32
ZAM.MAIZE	1599296.482	1599296.482	61.22	61.22
ZAM.WHEAT	81827.957	96666.667	279.00	279.00
ZAM.SORG	67750.496	67750.496	39.37	39.37
ZIM.MAIZE	1833071.429	1833071.429	50.08	50.08
ZIM.WHEAT	342161.775	356076.923	279.00	279.00*
ZIM.SORG	180035.714	180035.714	53.83	53.83

Appendix C-1 Continues

Free Trade

	Demanded	Quantity Supplied	Demand Price	Supply Price
BOT.MAIZE	80042.592	17216.150	58.18	58.18**
BOT.WHEAT	50906.831		256.00	
BOT.SORG	67966.757	45417.597	47.21	47.21**
MAL.MAIZE	1797879.377	1797879.377	46.84	46.84
MAL.WHEAT	64082.415	5217.57	298.00	298.00*
MAL.SORG	56912.821	56912.821	33.36	33.36
RSA.MAIZE	4967968.910	5030795.353	43.18	43.18
RSA.WHEAT	2954716.981	2787312.500	241.00	241.00
RSA.SORG	390527.099	413076.258	32.21	32.21
TAN.MAIZE	2777113.095	2777113.095	70.52	70.52
TAN.WHEAT	166667.585	181094.972	249.00	249.00
TAN.SORG	580953.333	580953.333	13.33	13.32
ZAM.MAIZE	1599296.482	1599296.482	61.22	61.22
ZAM.WHEAT	81612.903	97017.544	275.00	275.00
ZAM.SORG	67750.496	67750.496	39.37	39.37
ZIM.MAIZE	1833071.429	1833071.429	50.08	50.08
ZIM.WHEAT	323807.856	338850.144	277.00	277.00*
ZIM.SORG	180035.714	180035.714	53.83	53.83

* Prices decreases as openness of trade occurs.

** Prices did not change as openness of trade occurs because trade of these commodities, which is between South Africa and Botswana is not affected by tariffs since they are members of SACU.

SORG = Sorghum

Appendix C-2 Market Clearing Prices and Quantities After

Adjustment of Elasticities

10% Increase in Elasticities

	Quantity DEMANDED	Quantity SUPPLIED	Demand Price	Supply Price
BOT.MAIZE	75798.418	21612.297	71.51	71.51
BOT.WHEAT	50968.925		256.00	
BOT.SORG	68242.493	46102.327	54.15	54.15
MAL.MAIZE	1834529.333	1921754.216	53.90	53.90
MAL.WHEAT	62977.558	5626.611	306.00	306.00
MAL.SORG	57564.888	57564.888	38.11	38.11
RSA.MAIZE	4603747.215	3957794.851	98.51	98.51
RSA.WHEAT	2959458.333	2803586.207	241.00	241.00
RSA.SORG	389821.630	411961.796	39.15	39.15
TAN.MAIZE	2784077.670	2784077.670	70.11	70.11
TAN.WHEAT	169384.848	181895.706	235.00	235.00
TAN.SORG	593378.812	593378.812	10.82	10.82
ZAM.MAIZE	1364763.050	1526979.550	62.90	62.90
ZAM.WHEAT	79422.850	70014.062	297.00	297.00
ZAM.SORG	69376.321	81163.749	30.51	30.51
ZIM.MAIZE	1611460.059	2062157.161	80.90	80.90
ZIM.WHEAT	327231.111	360899.160	279.00	279.00
ZIM.SORG	184990.939	173203.511	48.51	48.51

10% decrease in Elasticities

BOT.MAIZE	81836.625	15566.793	26.67	26.67
BOT.WHEAT	52968.480		214.00	
BOT.SORG	67815.747	44408.965	37.79	37.79
MAL.MAIZE	1758533.135	1737509.240	43.89	43.89
MAL.WHEAT	70332.599	3946.175	218.00	218.00
MAL.SORG	56274.148	56274.148	27.58	27.58
RSA.MAIZE	5072966.580	5139236.412	11.67	11.67
RSA.WHEAT	3006517.243	2823942.859	241.00	241.00
RSA.SORG	387754.830	411161.611	22.79	22.79
TAN.MAIZE	2762486.487	2762486.487	70.26	70.26
TAN.WHEAT	169184.385	169184.385	244.82	244.82
TAN.SORG	572964.660	572964.660	10.16	10.16
ZAM.MAIZE	1353398.149	1353398.149	34.05	34.05
ZAM.WHEAT	88902.885	62548.882	209.00	209.00
ZAM.SORG	68053.033	74397.749	22.60	22.60
ZIM.MAIZE	1679730.726	1700754.620	16.89	16.89
ZIM.WHEAT	36274.088	284780.822	191.00	191.00
ZIM.SORG	181231.391	174886.675	40.60	40.60

VITA

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