AN ANALYSIS OF IMPORT TARIFF ESCALATION: A CASE OF MAIZE TRADE BETWEEN SOUTH AFRICA AND MOZAMBIQUE

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ABSTRACT

AN ANALYSIS OF IMPORT TARIFF ESCALATION: A CASE OF MAIZE TRADE BETWEEN SOUTH AFRICA AND MOZAMBIQUE

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Recent World Trade Organization negotiation rounds have focused on import tariff escalation, which occurs when import tariffs increase as the processing level increases. Although typically researched as a trade policy used by developed countries to protect their agro-processing sector, this research examines the effects of import tariff escalation when used by a developing country. Specifically, this thesis examines import tariff escalation (and the value-added tax) applied by Mozambique to imports of maize and maize flour from South Africa. Using econometrically estimated domestic supply and demand elasticities for each region, this thesis uses a spatial, partial equilibrium model to maximize social welfare subject to material balances and price constraints to model the changes in prices and export quantities due to a removal of import tariff escalation, the value-added tax, and a simulated ‘free’ trade environment. Although data availability was limited and thus decreased the statistical validity of the econometrically estimated elasticities, sensitivity tests indicated the models robustness to small changes in the elasticities. The model simulations indicated the removal of the VAT had very little effect of changes in prices or export quantities, while considerable changes were found in the simulated removal of import tariff and the ‘free’ trade simulation.

To My Parents

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KEY TO SYMBOLS AND ABBREVIATIONS

Abbreviation	Definition
04 Met	2004 Mozambique new Metical's
APC	African & Pacific Countries
CIF	Cost, Insurance & Freight
CIM	Compannia Industrial da Motala
CPI	Consumer Price Index
EEC	European Economic Community
ERP	Effective Rate of Protection
EU	European Union
FAO	Food and Agriculture Organization
FEWSNET	Famine Early Warning System
FOB	Free on Board
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
IAF	Inquierito aso Agregados Familiares
INE	Instituto Nacional de Estatistíca
KG	Kilogram
MEREC	Merec Industries
MT	Metric Ton
OECD	Organization for Economic Co-operation and Development
SADC	Southern African Development Community
UNCTAD	United Nations Conference on Trade & Development
V&M	Vonk Industries
VAT	Value-Added Tax
WTO	World Trade Organization

1. INTRODUCTION

1.1 Import Tariff Escalation

As globalization continues to evolve and countries adjust to increased integration of markets, countries seek potential markets for their products while continuing to implement barriers that obstruct the expansion of those markets. These barriers used to distort trade incentives and protect domestic industries include export subsidies, export taxes, quotas and import tariffs. Though past multilateral negotiating rounds of both the General Agreement on Tariffs and Trade (GATT) and the World Trade Organization (WTO) have focused on reducing these market barriers, many are still present and continue to distort trade and hinder development in many countries. One distorting trade policy that received attention during the Uruguay Round of negotiations was import tariff escalation in agricultural processing chains.

According to OECD (1997), import tariff escalation occurs when there is a zero or lower tariff on unprocessed or raw commodities, but a larger tariff on a processed form of the commodity. An example would be when a country has a low or zero import tariff on cocoa beans, a higher import tariff on cocoa powder and an even higher import tariffs on chocolate bars.

Import tariff escalation[1] has become a major issue during trade negotiations because it adds a higher level of effective protection to a country's processing and retail sector (OECD, 1997). As global trade expands, the protection of a country's processing sector has two separate negative effects dependent on if the escalating tariff is applied by

[1] Export tariff escalation, which is a less used trade barrier, occurs when the export tariff is greater on the lower the processing level product. In other words, if there is a higher export tariff on the raw commodity than the processed commodity then export tariff escalation exists. Nevertheless, the goal of the escalating export tariff is the same, to protect the local processing industry.

a developed or developing countries. The most discussed and researched effect of import tariff escalation is the use by developed countries and its negative impacts on developing countries. More specifically, the use of import tariff escalation by developed countries inhibits developing countries' ability to diversify their export portfolio, increase their trade in processed commodities, and reduce their reliance on exports of raw commodities (Elamin and Khaaira, 2004). Alternatively, the use of import tariff escalation by developing countries, specifically on imports of staple commodities, can create negative impacts, especially for its consumers, as the protected processing industry is allowed to produce less efficiently, while using market power to increase the retail price of the processed commodity.

1.1.1 Developed Countries

Historically most developing countries have focused on exportation of raw commodity products. However, as noted by Elamin and Khaira (2004) many different factors have lead to an increased interest of developing countries to play a larger role in the processing of agricultural commodities. The first factor is the continued emphasis on diversification of a country's export portfolio for sustainable economic growth. Developing countries acknowledge that focusing exports on only one or two raw commodities makes the country highly sensitive to instability caused by poor production years, natural disasters, or declining world market prices. Another factor leading to the change in developing countries is the growing urban labor force in developing countries due to migration from rural to urban areas. Processing industries would thus provide another employment option for the growing urban population. Third, there is growing awareness of environmental problems caused by over-exploitation of natural resources, causing developing countries to pursue greater control over their own raw commodities. The final factor is the growth in global demand of agriculture processed products as compared to raw commodities. Developing countries see the growth of demand for processed products as compared to demand for raw commodities and acknowledge that if a shift is not made, their economy will decline due to a loss in exports. This final factor brings the emphasis back to the most important point of the need for diversification in the export portfolio.

Elamin and Khaira (2004) indicate that the agriculture processing sector as a share of world trade has increased since 1980. In a twenty year period, from 1980 to 2000, processed agriculture products increased its share in total value of world trade by 6 percent, while primary products trade value only increased by 3.3 percent of the total value traded. The decrease in importance of primary products has been caused by low income elasticity of demand, coupled with the decline in economic activities in which primary products are intensely used, along with the overall structure of the commodity markets (Elamin and Khaira, 2004).

This shift towards trade of processed products, as compared to primary products, has large negative effects on developing countries economies as they tend to be the leader in exports of primary products. In addition to the decreasing importance of primary products trade, developing countries are losing their share in the trade of agriculture processed products. Elamin and Khaira (2004) note that overall the share of agriculture exports of processed products from developing countries decreased by 2 percent, while the share of agriculture processed products as a whole was increasing. Countries classified as least developed countries also had a decrease in the share of agriculture exports in processed products from 0.7 percent to 0.3 percent over the same time period.

This trend can be seen in an example of cocoa. Elamin and Khaira (2004) compiled the top ten cocoa producing developing countries and found that as the stage of processing increased the share that developing countries had in that product decreased. The results indicate that the top ten developing countries shares of world exports from 1996 to 1999 were 83 percent for cocoa beans, 30 percent for cocoa butter, 28 percent for cocoa powder and 1 percent of chocolate. To illustrate that the growth of the export processing sector the authors note that in 1970 chocolate exports were 20 percent of total cocoa products world exports, however by 1996 chocolate exports were 56 percent to total coca products world exports. The authors also noted that the same trend could be found for the top ten developing countries producing coffee.

Therefore, due to the importance that agriculture plays in developing country economies and the changing preferences in world trade of agriculture products, it is important that trade-restricting policies not be used to further hinder developing countries export potential.

1.1.2 Developing Countries

As mentioned above, developed countries are not alone in applying escalating import tariffs on agriculture commodities. Developing countries use import tariff escalation as a means of protecting their own agricultural processing industries. Most developing countries throughout Africa, Asia and Central and South America use some type of import tariff to protect their main staples (WTO, 2008). However, literature that examines the impacts of import tariff escalation on domestic consumers and producers in developing countries is limited. Valenzuela *et al* (2004) are one of the few authors to address the impacts caused by the removal of import tariff escalation. The authors examine social welfare changes due to tariff removal on smallholder livestock producers in developing countries. The authors conclude that both in the short and long run, poverty for the majority of countries examined would be reduced through the elimination of domestic import tariffs

1.2 Overview of the Problem

Mozambique is a prime example of a developing country using import tariff escalation as a means of protecting its maize processing industry[2]. Mozambique and South Africa are both members of the South African Development Community (SADC), which is a free trade block of fourteen southern African countries. Trade in maize, however, which is considered a sensitive commodity, is exempt from this free trade agreement. Mozambique currently applies a 20 percent import tariff on maize flour entering from South Africa, while only applying a 2.5 percent import tariff on maize grain imports from the same country[3]. Mozambique has an additional import policy to further protect its industrial maize processors. The country applies a 17 percent Value Added Tax (VAT) on all maize grain entering the country. The combination of the VAT and import tariff on grain equals the import tariff applied on maize flour, thus making it appear that Mozambique has high import barriers on all products rather than an escalating

[2] Mozambique is currently discussing applying export tariff escalation to the cashew sector to protect the cashew processing sector.

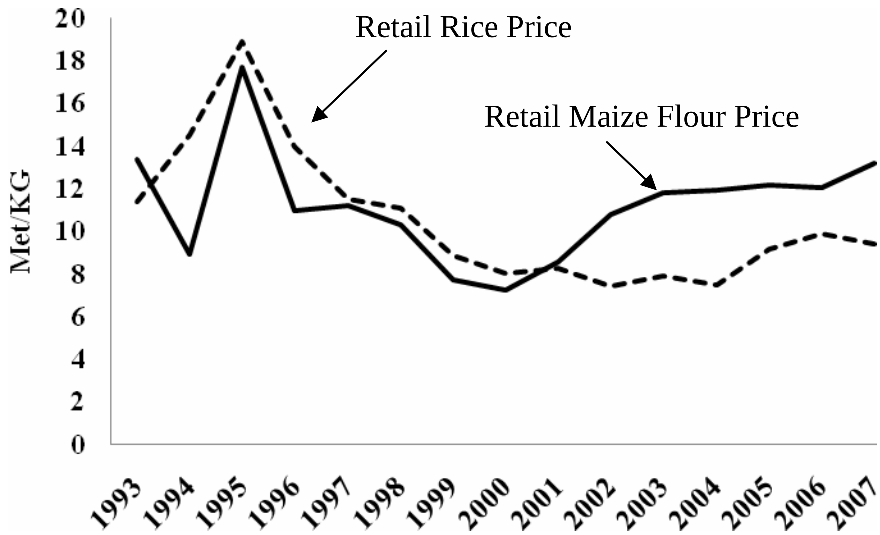
[3] Given the current "food price crisis", Mozambique is discussing changing their import tariff policy on basic staples, including maize.

import tariff problem. However, further investigation into the VAT reveals that the 17 percent VAT is reimbursed as long as the grain is being imported to be processed into maize flour by an industrial processing company. On the other hand, if the grain being imported for use at smaller hammer mills or homes, then the VAT is not reimbursed. Therefore, the combination of a high escalating import tariff on maize flour, combined with a high VAT on maize grain that is exempt for industrial maize processors further illustrates the Mozambique government's protection of the industrial maize millers in the country.

The importance of this topic is heightened by the recent trends in local maize prices in Mozambique. Maize grain has traditionally been the number one staple for the urban poor and rural populations in Mozambique. However, maize grain and flour prices, which were traditionally below the cost of rice, have been increasing more rapidly than rice prices (Figure 1.1). Tschirley and Abdula (2007) argue that this increase in maize grain and maize flour prices in Mozambique is not caused by world price changes but the domestic maize market structure. The authors explain that beginning in 2002, maize flour prices in Maputo began increasing, eventually peaking in late 2004 and then stabilizing in 2006, with similar trends occurring in the center region of Mozambique, sometimes to a higher degree. During this same time period, Zambian maize flour prices were significantly lower than Mozambique prices with a surge in late 2005, due to a sharp appreciation of the Zambian Kwacha. Even with this surge, maize flour prices in Zambia were still almost half the cost per kilogram (kg) as compared to Mozambique, with similar results found in other surrounding countries.

Affordability of maize grain and maize flour, especially for poor consumers throughout Mozambique, is heightened by the current increasing price of maize and maize flour on the world market. It therefore becomes imperative to examine the domestic impacts of the restricting import policies applied to maize grain and maize flour, specifically, given the importance of maize and maize flour as a food staple.

Figure 1.1: Real Staple Food Prices in Maputo, 1993-2007



Data Source: SIMA (2008)

1.4 Research Objectives

The general objective of this research is to empirically measure the changes in prices and quantities traded that would occur in Mozambique with a change in import tariff policy. The specific objectives of this research are to:

a) Describe the maize market structure and industrial maize milling industry in both Mozambique and South Africa, including the current trade situation between the two countries, and the import tariffs and VAT applied to maize grain and maize flour originating from South Africa.

b) Provide a review of prior research on import tariff escalation.

c) Create a model of maximum net social monetary welfare under different tariff scenarios.

d) Estimate elasticities of supply and demand for maize grain and maize flour in three relevant geographic regions that will be used to make the net social monetary welfare model operational.

e) Make policy recommendations on Mozambique's import tariff escalation and VAT policies based on the results of the tariff simulations.

1.5 Thesis Organization

This thesis is organized to accomplish the objectives defined above. Chapter 2 will examine the maize sector in Mozambique and South Africa and the trade relationship between these two countries, including an in-depth discussion of the import tariff and VAT policies applied to maize and maize flour traded between South Africa and Mozambique. Chapter 3 will review the literature of past research in import tariff escalation analysis to identify the knowledge gaps that need to be filled and the methods used to analyze import tariff escalation. Chapter 4 will describe the theoretical framework of the social welfare maximization model used in the analysis. Chapter 5 provides the theoretical framework for the supply and demand estimations, in addition to the empirical supply and demand models used, data description, and results from the estimations that will be used to make the social welfare model operational. Chapter 6 starts with a detailed description of the empirical model and parameters used for the net monetary social welfare model and finishes with results from the baseline and alternative tariff scenarios. Finally, Chapter 7 concludes with an overall summary of the research and findings, implications, and opportunities for further research on this topic.

1.6 Conclusion

This chapter has provided a brief introduction to the economic consequences of import tariff escalation that occurs when applied by both developed and developing countries. Mozambique was introduced as the subject of this research due to their application of escalating tariffs import on maize grain and maize flour imported from South Africa. A short introduction to the current situation in Mozambique has been provided. Before analysis of the import tariffs can be conducted, the maize market system in Mozambique and, to a lesser degree, South Africa must be understood. The following chapter will provide detailed information related to the complex maize market in Mozambique, including details on both production and consumption of the commodities. In addition, the chapter will provide a brief description of the maize market system in South Africa and details on trade patterns between the two countries and a more in-depth look at the tariffs used by Mozambique.

2. MAIZE MARKET

2.1 Mozambique

Mozambique is a large country on the south-eastern coastline of Africa stretching north-south along 2500 km of the Indian Ocean. The country is divided into ten provinces and three regions. In this study, Maputo, Inhambane and Gaza provinces form to make the southern region, while Manica, Sofala and Tete make the center region, leaving Zambezia[4], Nampula, Cabo Delgado, and Niassa to form the northern region.

According to the Instituto Nacional de Estatistíca (INE), almost 20 million people populated Mozambique in 2006, of which 25 percent were located in the southern region, 15 percent were residents of the central region and the remaining 60 percent were in the northern region of Mozambique (1997). While the majority of the country, 70 percent, is labeled as rural, over 40 percent of the southern region is classified as urban, and approximately 80 percent of the population in Maputo province is categorized as urban (INE, 1997).

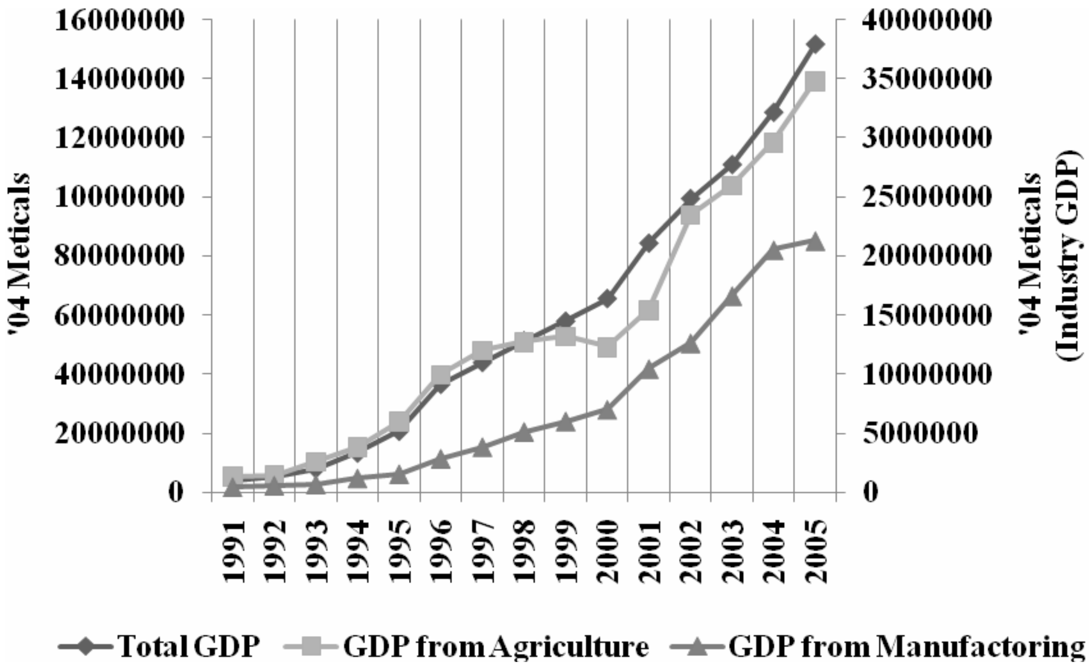
Mozambique's economic development has suffered various setbacks. Economic growth began to decline with the end of Portugal's colonial rule of Mozambique in 1975 and further decreased through the 1980's, as civil war engulfed Mozambique. As one can see in Figure 2.1, with the end of the civil war in 1992, economic growth increased rapidly[5] throughout the post-war era (1993 to 1998) due to good crop production years, increased political stability and large foreign investments (Jones, 2006). Due to importance of agriculture to the GDP, slight dips in economic growth occurred during

[4] While official statistics often group Zambezia with the center region, for market analysis, Zambezia is more integrated into the northern region. The bridge currently being constructed over the Zambezi River may change the current market integration dynamics of Mozambique.

[5] GDP growth averaged around 8 percent during the post – war era, with the largest growth occurring in 1993 with a 20 percent increase.

1999 and 2000 caused by poor rainfall and intensive flooding that led to poor production years. Economic growth continued after 2000, but at a slower, less intensive rate (approximately 3 percent) than experienced during the early post-war era. In recent years, economic growth has been rapidly increasing (around 7 percent) due to large investments in industry.

Figure 2.1: Mozambique Gross Domestic Product, per capita



Source: INE (2008)

Agriculture is still the main contributor to the Mozambique economy, providing over 75 percent of employment for the population and contributing slightly less than 25 percent to the GDP. The majority of production occurs on small household farms[6] with commercial farms focusing on exportable and/or cash crops. Arable land availability in Mozambique amounts to 36 million hectares, while only around 10 percent of the 36

[6] Small farms are defined as less than 10 hectares.

million hectares is currently being used. In addition, the country offers a wide variety of soil types and climate conditions making it suitable for production of a wide range of crops (Sebei, 2002).

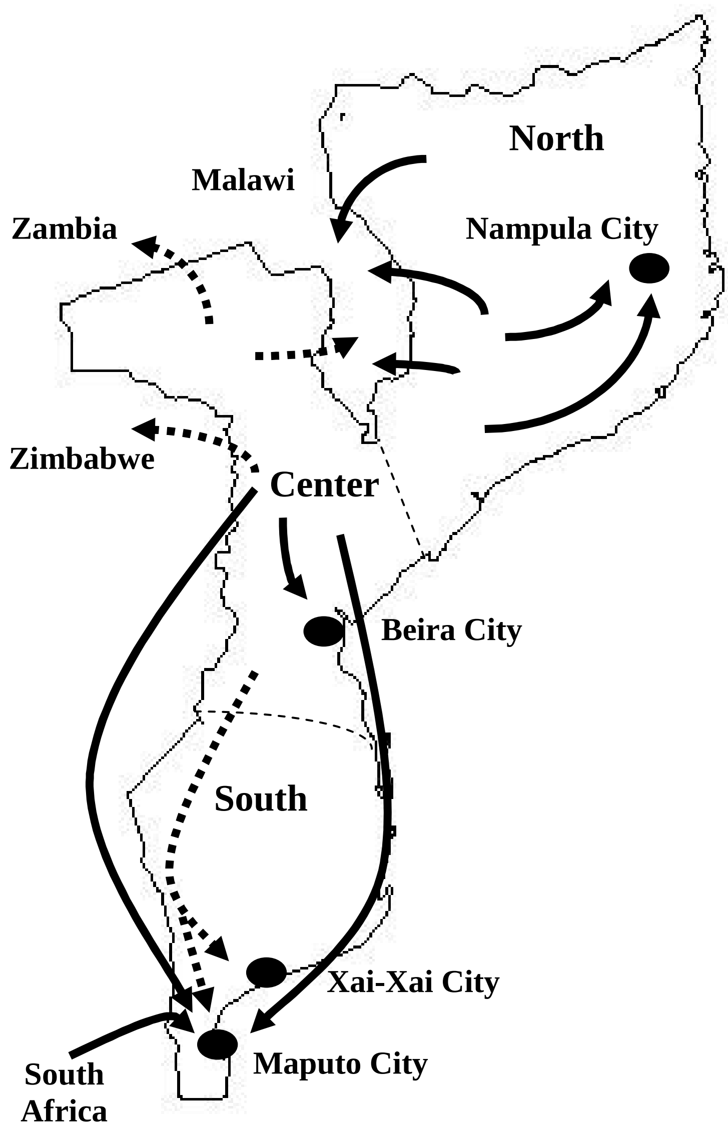
2.1.1 Market Structure

In Mozambique, maize grain[7] is the most widely produced, sold and consumed staple among the country's several food staples. Additionally maize is the only staple that is exported on a regular basis, primarily from the northern region, but also occasionally from the center providing income to rural maize-producing households. The majority of maize grain, around 90 percent, is produced in the northern and central regions of Mozambique, while the majority of the urban population and rural net purchasers of maize grain live in southern Mozambique.

Transport is an important factor in the flow of maize grain from the production to the consumption zone. Mozambique has poor infrastructure in all main methods of transport, including roads, railroads and sea links, and rail options from the north to south are nonexistent. During colonial years, railroads were built east to west to move raw materials from inland to the coast, however these are not consistent with today's need to move staples north to south.

[7] Unless otherwise noted, maize grain refers to white maize grain only. Mozambique uses white maize grain for human consumption, while yellow maize grain is used for animal feed and for human consumption only during extreme food insecurity. Therefore, in this research, yellow maize will only be considered for use other than human consumption.

Figure 2.2: Map of Mozambique with Regions and Maize Flow Patterns



Source: Abdula (2005)

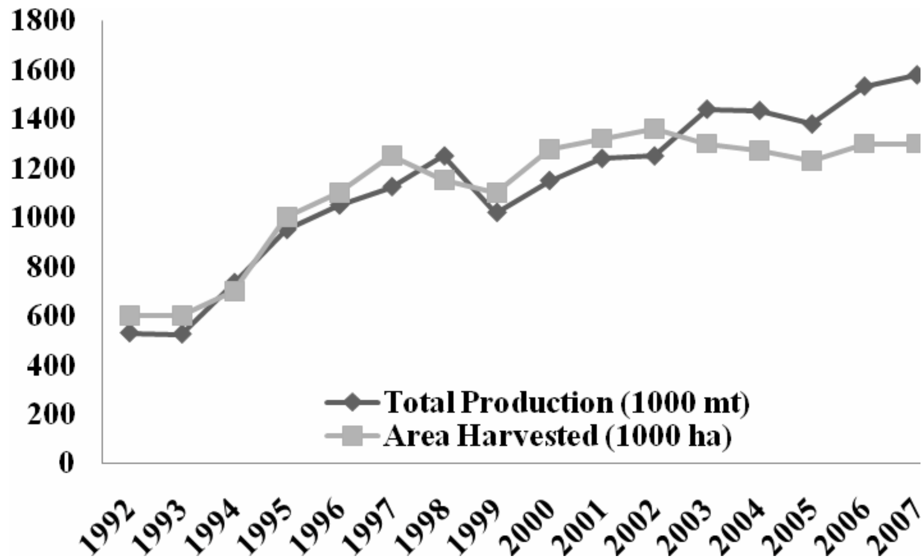
Movement of grain from the north and center to the south by road is difficult and costly due to distance, combined with low road quality and increased fuel prices. Many portions of the road are likely be poor as World Road Statistics (2008) estimated that in 2002 only 19 percent of roads were surface paved, with an additional 27 percent paved in gravel. Additionally, high diesel fuel prices, which increased by 610 percent in real price terms from February of 1995 to December 2003, make transport of maize grain by road extremely expensive (Abdula, 2005). The distance from Lichinga, the capital of Niassa in the northern region and an important production zone, to Maputo is over 1800 kilometers and truck transport is the only viable option. Although the transport cost from the north per kilometer is comparable to the cost per kilometer from the center, the added distance increases overall transport cost to a minimum of 1800 Meticals/ton (SIMA, 2008).

An additional access problem for movement of maize grain from the north to the southern region of the country is created by the Zambezi River. Only one large commercial ferry, between Tete and Zambezia provinces provides access across the river. In addition, during the rainy season movement across the river typically becomes impossible due to flooding. A new bridge is being constructed but until then, the Zambezi River forms a natural border between the north and the rest of Mozambique creating two natural, separate markets within the country (Figure 2.2). Therefore, this research will focus on the market area of central and southern Mozambique.

2.1.2 Production

As noted earlier, maize is the most widely produced staple throughout Mozambique. Total maize production in Mozambique has been increasing throughout the last fifteen years (Figure 2.3). Data suggest that this increase in production is due more to additional land being added to production than increased productivity, as yields have consistently fluctuated around 1 mt/ha. Figure 2.3 illustrates the increasing trend in production and land cultivated for maize, although the additional land added into maize production is minor compared to the amount of arable land still available for production. It is estimated that 88 percent of arable land has not been cultivated in Mozambique.

Figure 2.3: Total Maize Production vs. Total Area Harvested for Maize



Source: USDA-FAS Production, Supply and Distribution Online Database

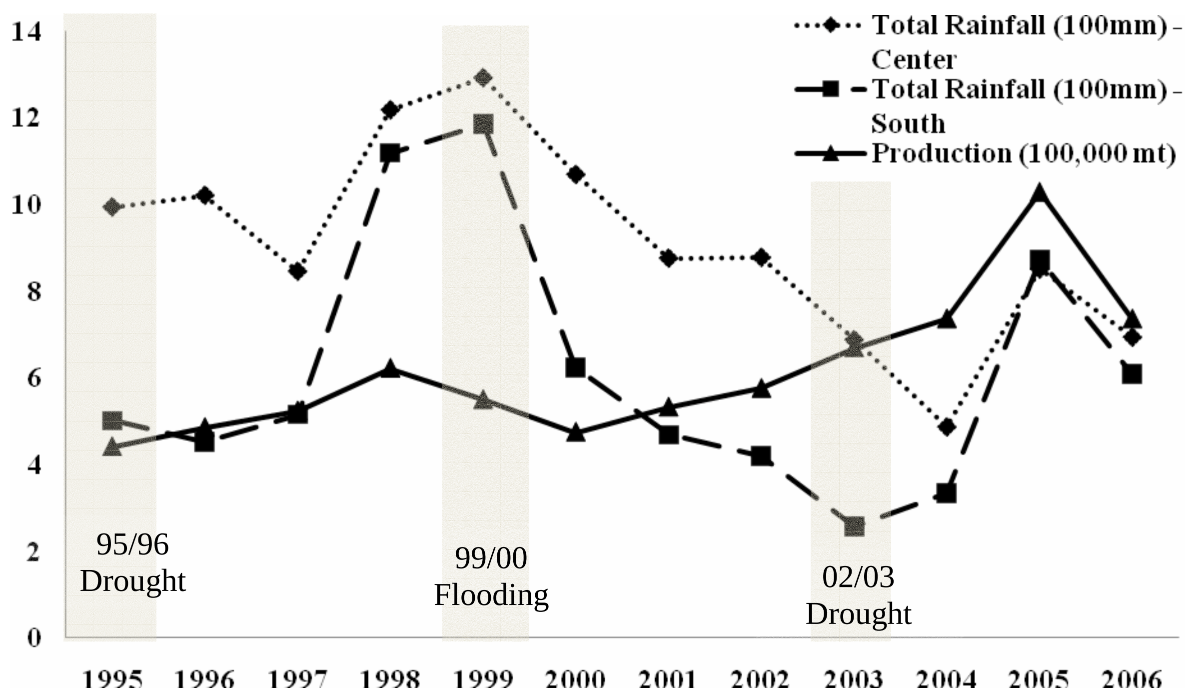
Most maize is produced on small household farms for home consumption with few inputs. The majority of households use seed from the previous year with no fertilizer[8] or irrigation. Therefore, total production is highly dependent on rainfall. Figure 2.4 illustrates the high dependence of production on rainfall, as yield does not vary throughout the years but total production in the central and southern regions moves with rainfall.

Rainfall varies throughout the country, thus affecting regional production differently. According to Tschirley and Abdula (2007), the northern region typically has higher total production because the region generally has more reliable rainfall (along with

[8] Only 3.5 percent of farms in Mozambique use chemical fertilizer (Cunguara, 2008)

better soil quality). Rainfall in the north tends to be independent and is not correlated with rainfall in the central and southern regions of the country. However, rainfall in the center and southern regions due tend to be correlated (Figure 2.4). This lack of rainfall correlation between the north and the rest of the country can be seen during years of drought in the center and southern regions, while the north remains relatively unaffected, such as 1992/1993. The center also tends to have better rainfall than the southern region, but is still more variable than the north (Tschirley and Abdula, 2007).

Figure 2.4: Total Rainfall and Total Maize Production, Central/Southern Mozambique



Source: USDA-FAS Production, Supply and Distribution Online Database (2008), FEWSNET(2008)

The trend of higher production in the northern and central regions can be seen for the 2006/2007 crop season. According to the 2007/2008 Famine Early Warning System (FEWSNET) Projected Food Balance Sheets (2007), a little over 1.5 million metric tons of maize was produced. Of that 1.5 million tons, 57 percent was produced in northern Mozambique, 37 percent was produced in the central region and the remaining amount, approximately 6 percent was produced in southern Mozambique.

Data on total production can be deceiving since a majority of the maize produced is never sold on the market. As Table 2.1 indicates, in the 2001/2002 season[9], 50 percent of maize was produced in the north, almost 40 percent was produced in the center and almost 10 percent was produced in the south, which is comparable to production percentages for the 2006/2007 season discussed above. Percent of national sales is equivalent to percent of production. However, the percentage of households selling on the market is more evenly distributed in the northern and center regions. In 2002, approximately 24 percent in the north, 23 percent in the center and almost 4 percent of households in the south were selling their maize on the market (Abdula, 2005).

Table 2.1: Percent Maize Production and Sales, 2001/2002

	North	Center	South
Percent of National Production	50.5	39.8	9.6
Percent of National Sales	59.1	38.5	2.4
Percent of Households Selling Maize	24	23.4	3.8

Data Source: IAF (2002), Abdula (2005)

2.1.3 Consumption

Maize grain and flour are the primary staples in both rural and urban areas throughout Mozambique, although consumption patterns have been shifting in the recent years, due to the relative changes in retail prices of the basic staples (Figure 1.1) and a general shift in, specifically urban, preferences for rice and wheat products. As can be

[9] The 2001/2002 season is used because it is the most current household survey data available.

seen in Table 2.2, when aggregated across the entire country to include both rural and urban areas, maize and maize derivatives continue to dominate total expenditure of cereals with a little over 15 percent of expenditure in both 1996 and 2002 according to Inquierito aso Agregados Familiares (IAF), a Mozambique government household consumption and budget survey, while rice only accounts for around 4 percent of total expenditure allocated to cereals.

Table 2.2: Food Expenditure Allocated to Cereals, National

	IAF 1996	IAF 2002
	Percent	
Maize and Maize Derivatives	15.44	15.45
Rice	3.84	3.76
Wheat and Wheat Derivatives	1.66	1.31

Data Source: IAF (1996), IAF (2002), and Abdula (2005)

It should be noted that expenditure patterns vary greatly by rural and urban areas. Table 2.3, shows the total expenditure percentages for cereals for 1996 allocated to the same categories separated into rural and urban categories. The percent of total cereal expenditure allocated to maize and maize derivatives decreases to around 10 percent for urban areas while over 16 percent of expenditure allocated to cereals is spent on maize and maize derivatives in the rural area. Table 2.3 also illustrates that urban households decrease their total cereal expenditures allocated to maize and maize derivatives and increase their total expenditure of cereals spent on rice and wheat to over 5 percent.

Table 2.3: 1996 Food Expenditure Allocated to Cereals, Urban and Rural

	Urban	Rural
	Percent	
All Cereals	22.7	22.8
Maize and Maize Derivatives	10.56	16.68
Rice	6.77	3.09
Wheat and Wheat Derivatives	5.28	0.74

Data Source: IAF (1996) and Abdula (2005)

Expenditure patterns also vary across provinces (Table 2.4). In the highly urban province of Maputo, the urban population slightly increased total expenditure for cereals spent on maize from 1996 to 2002, although it still remained under 3 percent with a majority of their cereal expenditure spent on maize substitutes such as wheat products and rice. Overall, rural areas of Maputo province allocated slightly more of their total cereal expenditure to maize and maize products, however, from 1996 to 2002, total cereal expenditure spent on maize decreased by 7 percent. During the same time period, the rural Maputo population increased their total expenditure of cereals spent on rice by 5 percent. However, maize remained an important staple, over 10 percent was allocated to maize expenditure in both the rural and urban areas of Gaza and Inhambane, while over 40 percent of total cereal expenditure was allocated to maize in the rural and urban areas of Manica and Tete. Therefore, even with increasing prices of maize products as compared to other staples as discussed in Chapter 1, it still remains an important staple throughout Mozambique.

Table 2.4: Food Expenditure Allocated to Cereals, by Province and Urban/Rural

	Maputo		Gaza and Inhambane		Manica and Tete		Sofala	
	Urban							
	1996	2002	1996	2002	1996	2002	1996	2002
	Percent of Total Food Expenditures							
Maize	1.1	2.4	10.1	14.5	24.6	39.9	19.4	27.5
Rice	15.0	7.8	16.2	9.8	6.1	4.4	8.9	9.2
Wheat	21.7	15.5	16.3	6.0	5.9	2.9	8.5	4.2
	Rural							
	1996	2002	1996	2002	1996	2002	1996	2002
	Percent of Total Food Expenditures							
Maize	16.4	9.1	22.4	12.0	23.2	48.0	18.8	26.7
Rice	6.2	11.4	5.7	9.5	1.1	2.5	7.8	6.5
Wheat	6.1	7.4	3.4	3.2	0.9	1.4	0.5	1.7

Data Source: IAF (1996), IAF (2002), Abdula (2005)

2.1.4 Milling Industry

As explained by Tschirley and Abdula (2006), there are three main types of maize millers in Mozambique. The first is home milling, where the household buys or produces the maize grain and hand pounds the maize to produce the maize flour. Secondly, there are small-scale hammer mills, where the customer provides the maize grain and the hammer mill provides the service of pounding, usually producing a straight run meal. Finally, there are industrial millers who purchase maize and then process and sell various qualities of maize flour at wholesale and retail levels. Different qualities of maize flour can be produced from these different milling options. Extraction rates can go from 100 percent, where all of the maize grain is used in the creation of the flour (typical of small-scale hammer mills), to 65 percent extraction rate where the maize germ and other components are removed. For this study, only the highest quality of maize flour will be examined.

Within the last 15 years, large industrial millers in Mozambique have started to gain market share. Throughout the 1980's, the maize milling industry declined due to poor management and the inability to obtain inputs due to the political instability. By the mid-1990's, Compannia Industrial da Motala (CIM), a large industrial maize milling company in the southern region of Mozambique, was privatized and operating as the only maize miller in southern Mozambique. Today Merec Industries (Merec) is the only real competitor for CIM in the commercial maize milling industry in southern Mozambique. According to a survey conducted in 2005, these two companies held over 70 percent of the maize flour market in both central and southern Mozambique, and 100 percent of the market in Maputo City (Tschirley and Abdula, 2007). However, CIM with its highest quality maize flour, Top Score, continues to dominate the market in Maputo City, which is reinforced by results from a 2007 survey (Tschirley and Abdula, 2007) that indicated in open air markets in Maputo, CIM held 70 percent of the market while Merec products were almost completely absent. This is consistent with results found in the supermarket during the same time period. A survey of the shelf space revealed that CIM's products occupied 70 percent of the shelf space, while Merec products had 13 percent and imported maize flour from South Africa had 5 percent of the shelf space (Tschirley and Abdula, 2007).

The dominance of CIM in the market may be important considering the increasing prices of maize flour. During the first few years of production, CIM's price was compatible to similar maize flour in surrounding countries. Beginning around 2002, Top

Score maize flour prices increased and by 2005 Top Score was three times the price of maize grain in Maputo, four times the price of maize grain in any other city in the center and southern regions of Mozambique, and double the equivalent brand of maize flour in Zambia and Malawi (Tschirley, *et al*, 2006). Nevertheless, competition from other large and small millers remains limited. In the last 5 years, other large industrial millers have opened in and around Maputo, including SMC and Inacio de Sousa, but, neither company's brand of maize flour is aggressively competing for market share in Maputo City (Abdula, 2005).

Vonk (V&M), one of the major industrial millers in the center region of Mozambique, has begun shipping maize flour to the south and targeting the Maputo market to gain market share. V&M, which uses maize grain produced in the center region of Mozambique, determined that even with the cost of shipping the maize flour from the center to the south, the current high cost of maize flour in Maputo offered an opportunity to enter the Maputo market. However, V&M's attempt seem to have been unsuccessful as it was not mentioned in the 2007 survey on maize flour in either the open air markets or retail stores (Tschirley and Abdula, 2007).

2.2 South Africa

Traub and Jayne (2008) explain that starting in the 1930's, South Africa's maize production was a single-channel system controlled by the government. A Maize Board set prices at every stage of the processing chain, including the producer maize grain and retail maize flour prices. In the 1980's the South African government recognized the inefficiencies caused by setting prices and controlling distribution and began the process of privatizing the maize marketing sector. By 1991, deregulation was in full force and maize flour prices were no longer set by the government. At the end of the 1996/1997 marketing season, the Maize Board was dissolved (Traub and Jayne, 2008).

2.2.1 Production and Consumption

South Africa is the leading producer of maize in the southern African region. In a typical year, South Africa produces more maize than Zimbabwe, Malawi, Mozambique, Zambia, Swaziland, Lesotho, Botswana and Namibia combined (Jayne, 1995). According the South African Department of Agriculture (2008), maize is produced in five provinces of South Africa, with most production occurring in the Free State province, followed by North West, Eastern Cape, Mpumalanga and finally KwaZulu-Natal. Planting typically occurs between October and December due to the rainfall variation, usually starting in the eastern part of the country and moving west. South Africa plants an average 3.8 to 4.8 million hectares of maize per year, which accounts for approximately 25 percent of total arable land in South Africa. Due to the lingering reminisces from the regulated production by the Maize Board, most maize production occurs on large commercial farms, as small-farms did not have access to contracts when the Maize Board regulated production. More specifically, approximately 400 large commercial farms supplied maize grain to feed 40 million people during the regulated era. Today, these commercial farms still produce the majority of maize grain used for commercial processing and exportation due to the strict phytosantary standards enforced by domestic and trade laws. On average, these large commercial farms produce 4.3 million tons of white maize per year (in addition to 3.9 million tons of yellow maize).

Additionally smaller farms produce around a half a million tons of white maize, mostly for household consumption (South African Department of Agriculture, 2008).

Maize is also considered the most important staple for domestic consumption by the population of South Africa. On average South African's consume around 4.4 million tons of white maize (and 3.1 million tons of yellow) each year that is supplied from domestic production, in addition to imports from the United States, Argentina and Kenya (Dept of Agriculture 2008).

2.2.2 Milling Industry

Traub and Jayne (2008) explain that before the deregulation of the maize market, a single-channel, regulated, government system created an institution where only certified producers could sell to the marketing board and only registered maize millers could purchase maize from the marketing boards, thus limiting competition in the production and processing sector. The number of industrial millers slowly decreased as many were consolidated. By the 1980's, only six industrial maize millers remained. The pre-determined producer prices and set marketing margins were intended to keep maize flour prices in line, however, the maize millers worked together to create a cost-plus pricing system, which led to significant increases in maize flour prices, while new entrants were blocked due to the nature of the maize marketing system(Traud and Jayne, 2008).

The deregulation of the maize marketing system was intended to eliminate the previous government created barriers to entry and in turn lead to a decrease the maize flour prices (Traub in Jayne, 2008). Deregulation permitted competitors, including small-scale millers, to enter the market and provide additional sources of supply for consumers.

Small-scale millers offered a range of different quality maize flours. Together these effects were intended to decrease maize marketing margins and in turn decrease maize flour prices. However, the intended results have not been observed. Traub and Jayne (2008) indicate that marketing margins rose up to 22 percent in the first three years of deregulation adding that today marketing margins continue to increase monthly.

Unfortunately for small-scale maize millers, industrial maize millers again have a comparative advantage, as the South African government requires maize flour to be fortified with vitamins if it is to be sold at a retail level. The additional inputs, including machinery, are expensive and access to the needed materials can be difficult to obtain, therefore creating a new barrier to entry. Such a policy favors large maize miller's creating a situation in which large maize millers could return to their oligopoly marketing practices (Jayne 2008).

2.3 South Africa – Mozambique Trade

Trade between South Africa and Mozambique dates back to the late 19th century. Originally a relationship built of the movement of migrant labor and transportation, trade and investment eventually became the focus. Although a seemingly obvious choice for trading based on their proximity to one another, Castel-Branco (2004) concluded that four main factors have shaped trade between Mozambique and South Africa. These are the regional strength of South Africa as a trading partner, South Africa's international economic standing in comparison to major trading powers, the weakness of Mozambique's economy and public policy, and finally the importance of minerals and energy in social, political and economic dynamics in South Africa.

Table 2.5: Historic Trade Patters between Mozambique and South Africa

	Exports from South Africa to Mozambique	Exports from Mozambique to South Africa
	Real 04 Meticals	
2003	1,677,448,897	82,984,649
2004	1,479,930,030	59,703,003
2005	1,804,614,718	56,172,132
2006	1,680,744,273	85,806,111

Data Source: SA Government Info (2008)

South Africa is Mozambique's main trading partner. South Africa accounts for over 40 percent of Mozambique's total imports, while Mozambique accounts for 20 percent of South Africa's total imports. Table 2.5 shows the past four years of total trade for Mozambique and South Africa in real Meticals. Mozambique's imports from South Africa are highly concentrated on maize, cereals, meal and pellets, while Mozambique's exports to South Africa are focused on nickel ores and concentrate and cotton (SA Government Info 2008).

South Africa's importance as a main importer into Mozambique extends into Mozambique's imports of maize and maize flour. In recent years, South Africa has typically been the main exporter of maize flour into Mozambique (supplying 100 percent of Mozambique's maize flour imports), and has become increasingly more important as main source for maize grain imports in Mozambique (Table 2.6). In 2005, South Africa's importance as a maize grain exporter to Mozambique increased from 30 percent of total maize grain imports to over 90 percent of Mozambique's total maize grain imports. In 2006, South Africa continued to be the main exporter of maize grain to Mozambique and accounted for over 75 percent of total imported maize grain into Mozambique.

Table 2.6: Imports of Maize Grain and Maize Flour to Mozambique, 2002-2006

	Imports to Mozambique - World	Imports to Mozambique – South Africa	Percent of Total Imports from South Africa
		Maize Grain (MT)	
2002	4,723	1,000	21.15
2003	21,135	7,686	36.37
2004	74,734	22,633	30.28
2005	39,911	37,303	93.47
2006	107,439	82,256	76.56
		Maize Flour (MT)	
2002	1,073	1,073	100
2003	1,259	1,259	100
2004	1,067	1,067	100
2005	3,453	3,363	97.39
2006	2,628	2,628	100

Source: United Nations UNCOMTRADE Database (2008)

Although, Mozambique increasingly relies on South Africa for a main source of maize grain and maize flour imports, Mozambique is not the primary destination of South Africa's exports of maize grain and flour (Table 2.7). In recent years, Mozambique has only accounted for a maximum of 30 percent of South Africa's maize flour exports (2006) and has accounted for as small as 2 percent of South Africa's maize flour exports (2002). Although increasing in recent years, exports of maize grain to Mozambique has only accounted for a maximum of 14 percent of South Africa's total exports of maize grain and again occurring in 2006, with the lowest percent of total exports, less than 1 percent, occurring in 2002.

In 1980, Mozambique was one of nine founding members of SADC whose original goal was to coordinate economic integration between the members and to lessen their dependence on then apartheid-controlled South Africa (SADC 2008). Shortly after South Africa ended apartheid rule in 1992, South Africa joined an additional 13 countries in SADC. Since its establishment in 1980, the goals of SADC have been amended and it currently serves as a free trade region, along with other development and economic growth activities. Although the block focuses on free trade agreements between member countries, some commodities are exempt from free-trade status and countries are allowed to apply tariffs based on the sensitivity of the commodity. Maize is one of the exempt commodities due to its importance in domestic food security. Mozambique uses this exemption to apply an escalating import tariff on maize and maize flour, in addition to a VAT to maize grain that together provide significant protection for Mozambique's domestic industrial maize processing industry (SADC 2008).

Table 2.7: Exports of Maize Grain and Maize Flour from South Africa, 2002-2006

	Exports to the World	**Exports to Mozambique**	**Percent of Total Exports to Mozambique**
		Maize Grain (MT)	
2002	478,275	1,000	0.21
2003	624,435	7,686	1.23
2004	423,535	22,633	5.34
2005	2,100,926	37,303	1.78
2006	603,861	82,256	13.62
		Maize Flour (MT)	
2002	60,807	1,073	1.76
2003	9,053	1,259	13.91
2004	5,053	1,067	21.11
2005	7,1047	3,363	4.73
2006	8,832	2,628	29.76

Source: United Nations UNCOMTRADE Database (2008)

2.3.1 Import Tariffs

Mozambique applies tariffs on all imports of maize grain and maize flour. An import tariff of 2.5 percent is applied to all maize grain imports and, as of January 1, 2006, a 20 percent tariff is applied to all maize flour imports. Prior to January 1, 2006, Mozambique applied a 25 percent tariff to all maize flour imports. The high tariff levels effectively protect the domestic maize processing industry, which can be seen by the low levels of maize flour imports (2,628 tons for 2006, all of which originated from South Africa) and the fact that only 5 percent of maize flour self space is devoted to imported maize flour (Tschirley and Abdula 2007). Mozambique is to have all import tariffs for maize flour eliminated by 2012 for all SADC member countries excluding South Africa, which will have the import tariffs eliminated by 2015 (Tschirley et al 2006).

2.3.2 Value Added Tax (VAT)

In 1999, Mozambique added a 17 percent VAT to their tariff schedule that is applied to maize grain. The VAT has two conditions that cause a disproportionate affect on maize grain as compared to its substitutes or maize flour. First, the VAT is not applied to imports of wheat or rice. As a result, imports of wheat and rice have a 2.5 percent import tariff applied to the free on board (FOB) price, while maize grain has the 17 percent VAT in addition to the same 2.5 percent import tariff applied to its FOB price. This leads imported maize grain to have a cost disadvantage compared to imported rice and wheat.

The second disadvantage occurs between imported maize grain for retail level sales and maize grain imported to be processed by large industrial millers into maize flour. The VAT regulation stipulates that imported maize grain that is purchased by large industrial millers and processed into maize flour will be reimbursed for the entire VAT. However, the VAT is not reimbursed, if maize grain is imported and sold on the retail level without processing or imported to be processed at a small-scale processor (Tschirley et al 2006).

These two conditions restrict imported maize grain on the retail level to almost zero. It also adds an additional level of market protection for the industrial maize processors, specifically in the south whose market is currently saturated by two maize processors. Southern industrial millers benefit from this current policy as it provides them a continual supply of maize grain without having to deal with unreliable supplies and high transport costs of maize grain from the center or northern regions of Mozambique. Southern industrial millers also benefit from higher quality maize grain from South Africa who impose and enforce higher quality standards than maize produced domestically within Mozambique.

The only disadvantage industrial maize millers face from the VAT is a loss in opportunity cost for the money used to pay the VAT. Although the government guarantees that the VAT will be reimbursed within three months (or the government will provide interest for the additional time taken to reimburse), industrial millers report varied results. Industrial millers do report that they receive the reimbursement, though the process is long and difficult (Abdula 2005).

2.4 Conclusion

This chapter has provided an in-depth look at the maize sector in Mozambique including detailed information on production and consumption trends throughout the country, and the maize milling sector. South Africa's maize market has been briefly summarized. The importance of trade between South Africa and Mozambique, specifically for Mozambique, has been outlined and a description of the import tariffs applied to maize and maize flour have been provided. Based on the information in this chapter, it should now be clear the importance of maize grain and maize flour throughout Mozambique. The next chapter will review previous research on the topic of import tariff escalation and begin to examine the appropriate method for measuring the effects of import tariff escalation on prices and quantities traded.

3. LITERATURE REVIEW

3.1 Introduction

There is a broad range of literature on the analysis of import tariff escalation, although no research has examined import tariff escalation in Mozambique. Nevertheless, the studies and methods of analysis used to examine import tariff escalation vary considerably, as do the countries and regions where the escalation occurs and has been studied. In addition, while import tariff escalation has been considered and researched as a north-south problem, it has begun to be examined as south-south trade issue as well, although the amount of research in that area is limited.

3.2 North – South Import Tariff Escalation Analysis

As noted in Chapter 1, analysis of import tariff escalation has historically examined the impacts on developing countries due to the use of escalating import tariffs by developed countries. The most popular methods for this type of analysis of import tariff escalation include (1) nominal tariff analysis and effective rate of protection (ERP) measurement, (2) partial equilibrium models, and (3) other economic based models.

3.2.1 Nominal Tariff Wedge and Effective Rate of Protection

Nominal tariff wedge analysis and Effective Rate of Protection (ERP) were previously the two most commonly used methods of import tariff escalation analysis, and both methods are still used today. Nominal tariff wedge analysis is one of the more elementary methods to analyze import tariff escalation. The nominal tariff wedge is calculated as the difference between the tariff applied to the processed and raw commodity. If the tariff wedge is greater than zero, import tariff escalation between the commodities is present (Tangermann, 1989). Alternatively, the ERP is calculated as the difference between value added to a processed good at the distorted trade prices and the value added to the processed good at the free trade price divided by the value added at the free trade price (Balassa, 1965; Corden, 1966).

Economists criticize the nominal tariff wedge approach because (1) it does not fully represent the protection caused by the import tariff escalation policy, (2) it provides no information on the effects of the value added to the product through the processing level, and thus cannot allow for comparison across commodities, and (3) it cannot be applied to the production function of multiple input or output analysis' (Lindland, 1997; Tangermann, 1989). Critiques of the ERP have also been made from both a theoretical and methodological standpoint (Antimiani *et al*, 2003; Greenaway and Milner, 2003; Anderson, 1998; Ethier, 1971, 1977; Tangermann, 1989). The authors collectively note that the model holds some very restrictive assumptions including: (1) domestic and foreign products are perfect substitutes, (2) no other trade restrictions, including quota and non-tariff trade barriers are present, (3) competition is perfect and (4) the importing country is a small, price taking country with no impact on the world price.

However, the strongest critiques occur with the assumptions made of fixed input coefficient and the neglect of general equilibrium repercussions from a change in import tariff escalation. The fixed input coefficient assumption does not allow for an accurate measurement of the protection added because the input-output ratio is not allowed to vary under different tariff rates, which would normally happen if substitutes for the inputs were available. Substitution elasticities would be needed to model this movement between inputs, but is not used and thus biases the level of protection calculation (Tangermann, 1989).

The disregard for the effects throughout the economy due to tariff changes is a major critique of both the nominal tariff wedge analysis and the ERP method. Specifically, in the analysis of a large sector of the economy or multiple small sectors that are aggregated together, the lack of acknowledgement of the change throughout the economy due to a tariff change is serious. Domestic incomes and expenditures, prices of inputs and substitutes, in addition to exchange rates may be affected due to a change in tariff policy and is not accounted for in either the nominal tariff wedge analysis or the ERP (Tangermann, 1989).

Even with these critiques, due to the seemingly straight forward method of calculation for measuring import tariff trade barriers, both methods have been used in a variety of studies to analyze import tariff escalation. The Organization for Economic Co-operation and Development (OECD) argues that the ERP measurement is almost impossible to use in agriculture import tariff escalation, due to the fixed input coefficient assumption in the model and the need for flexibility of the input coefficient based on agricultural processing. The OECD argues that the nominal wedge is just as useful as an ERP measurement because an overall decrease in the absolute value of the nominal tariff wedge implies a decrease in protection of the industry and that the direction of change is more important than the overall calculation of protection (OECD, 1997). However, most research on import tariff escalation typically uses the nominal tariff wedge approach as an introduction and then calculates the ERP to further examine the degree to which the processing chain is protected (Lindland, 1997; Chevassus-Lozza and Gallezot, 2003;

Humphrey, 1969; Milner, 1990; Greenaway and Milner, 1990; Greenaway and Milner, 1987; Hassan *et al*, 1992).

Lindland (1997) examined the impact on import tariff escalation due to policy changes that were negotiated in the Uruguay Round of the WTO using a nominal tariff wedge approach. Lindland analyzed over 200 different commodities in the three main agriculture markets (the United State, the European Union and Japan) between the years of 1992 and 1994. He found that over 80 percent of all tariff wedges in all three markets had converged to zero and commodities with the highest bound tariff wedges had the greatest reduction. Data difficulty including aggregation, processed products using multiple raw commodities for production, raw commodities used for multiple processed products, and matching the FAO and FAOSTAT data code for the nominal wedge analysis made the approach difficult to implement (Lindland, 1997). In an additional paper, Lindland attempted to calculate the ERP using the same data. However, the data were too aggregated and could not be used to complete a meaningful analysis of the level of protection added from import tariff escalation (Lindland, 1997a).

Chevassus-Lozza and Gallezot (2003) contended that the level of nominal protection, combined with the import tariff escalation along the production chain, provided reliable information on the sign of ERP, but not the degree of protection from the import tariff escalation, as claimed by the OECD (1997). However the authors felt the degree of protection caused by the escalating tariffs was needed to completely analyze import tariff escalation occurring between multiple developing countries and the European Union over major commodity groups. They sought to determine how a decrease in import tariff escalation, required by the Uruguay Round, would change the trading relationships between countries, specifically those with preferential trading agreements and sensitive geographic regions. The authors noted the difficulties of using the ERP model, including difficulty in identifying the processing chain and standardization/classifications of the tariffs, but used previous research for clarification.

Chevassus-Lozza and Gallezot (2003) first created a baseline using the current trading relationships and accessibility to European Union (EU) markets. The authors remark that imports into the EU had been increasingly originating from countries with preferential agreements with the EU. However, when differentiating between the types of preferential agreements, the authors found that countries with generalized system of preferences imported higher quantities to the EU than countries with bilateral trade agreements. The authors also noted that although there had been a slight increase in the percent of products being imported as processed commodities, the majority of agricultural imports into the EU were raw commodities, while exports from the EU were mainly processed commodities.

The authors then simulated the effect that the Harbinson Proposal[10] would have on import tariff escalation and trade of raw and processed goods, and found that in general, it would lead to a drop in tariff protection, of an average of 10 percent. Generalized system of preference countries would benefit the most from this proposal, while African and Pacific countries (APC) would be negatively affected as their preference margins decrease, specifically causing a decrease in exports of cereal,

[10] The Harbinson Proposal, presented to the WTO in 2003, proposed that (1) all ad-valorem tariffs greater than 90 percent be reduced to 60 percent, (2) reduce ad-valorem tariffs that are less than 90 but greater than 15 percent to 50 percent, and (3) for all levels below 15 percent ad-valorem, decrease by 40 percent.

fruits/vegetables, meat, sugar, and coffee/tea/cocoa, which are the primary export commodities in APC countries.

Hassan *et al* (1992) analyzed the Egyptian agriculture sector through the nominal tariff wedge approach and effective rate of protection. The authors examined 22 commodities, which accounted for 78 percent of the total Egyptian agriculture trade value between 1980 and 1987. The authors did not aggregate the commodities in an attempt to gain the best individual analysis of the commodities. After using the nominal tariff wedge to verify the presence of import tariff escalation, both Cordon and Balassa's approach were used to calculate the ERP. The authors found that when the market exchange rate was used, as compared to the official exchange rate, Egyptian agriculture production faced an overall disincentive due to the protective tariff structure.

3.2.3 Partial Equilibrium Models

Multiple researchers (Clark 1985, Golub and Finger 1979, Tangermann 1989, Wailes *et al* 2004) have measured the effects of trade policies, including tariffs, through the use of partial equilibrium models. First used by Cournot and Marshall, partial equilibrium models occur under assumed constant prices of substitutes/complements of the commodity and constant levels of income, therefore allowing only prices of the given commodity to adjust to create an equilibrium condition where supply equals demand.

Golub and Finger (1979) used a partial equilibrium model with fixed constraints to measure the effects of developing country export taxes and developed country import tariffs on trade, specifically on primary and processed products. The authors analyzed eight different commodities, including cocoa, cotton and coffee and aggregated all countries into two categories, developed or developing countries. Using data from 1973 on trade flows and production levels, the authors ran three different scenarios through the fixed coefficient, partial equilibrium model, which was based on six behavioral relationships of supply and demand of the different processed level products.

Table 3.1 presents the results found by Golub and Finger. As hypothesized, developing countries experienced overall increases in production of both primary and processed commodities and increases in export revenue under import tariff removal and the free trade scenario. Specifically, under the tariff removal scenario, developing countries would experience an average of 23 percent increase in processing, with cocoa, coffee and wool showing the greatest increases. Consumption of both the primary and processed commodities decreased under all three scenarios, however, the average change was under 5 percent in all three simulations. Although developed countries would see decreased processing under the tariff removal and free trade scenario, the average percent change was found to be no greater than 3 percent, with the copra processing sector experiencing the largest decline of around 40 percent under both scenarios.

Tangermann (1989) also used a partial equilibrium model, to analyze two different commodities, cocoa and soybeans. All major trading countries were grouped as either net importers or net exporters and developing or developed countries. Tangermann used consumption and production data from 1981 to 1983 and supply and demand elasticities provided by the Food & Agriculture Organization (FAO). Using the most favored nation tariff structure in ad valorem form and ignoring transportation cost, Tangermann analyzed both cocoa and soybean trade by comparing different free trade tariff scenarios to the current baseline situation. A brief outline of the results are presented in Table 3.2.

Table 3.1:: Results, Golub and Finger (1979)

	World	Developing Countries	Developed Countries
Scenario 1: *Removal of Import Tariffs*			
Consumption	Increase	Decrease	Increase
Primary Production	---	Increase	Increase
Processing	---	Increase	Decrease
Export Revenue	---	Increase	---
Scenario 2: *Removal of Export Taxes*			
Consumption	No Change	Decrease	Increase
Primary Production	---	Increase	Decrease
Processing	---	Decrease	Increase
Export Revenue	---	Decrease	---
Scenario 3: *Free Trade*			
Consumption	Increase	Decrease	Increase
Primary Production	---	Increase	Decrease
Processing	---	Increase	Decrease
Export Revenue	---	Increase	---

Source: Golub and Finger (1979), see for detailed results

Table 3.2: Results, Tangermann (1989)

	Results
	Cocoa
Scenario 1: *Import Tariff Removal*	• Overall increase in trade. • Developing Countries – small increase in processing.
Scenario 2: *Export Tax Removal*	• Overall - decrease in export revenue. • Overall - decrease in processing of beans and paste. • Overall - decrease in exports of butter and powder.
Scenario 3: *Free Trade*	• Exporters – decrease in foreign receipts. • Developing Countries – increase in first stage processing.
	Soybeans
Scenario 1: *Import Tariff Removal*	• Increase in world price of raw and processed commodities. • Developing Countries – increase in processing. • Developing Countries – negative foreign exchange.
Scenario 2: *Export Tax Removal*	• Developing countries – increase in export revenue • Overall – increase production. • Overall – decrease in world market price.
Scenario 3: *Free Trade*	• Developing countries – increase in export revenues. • Developed countries – increase in export revenues. • Importing countries – increase import expenditure on soybean commodities. • Overall – small increase in world price of both raw and processed commodities.

Source: Tangermann (1989), see for detailed results

In the cocoa analysis, Tangermann (1989) noted that the import tariff removal scenario did not indicate that the change in policy would transfer significant amounts of processing to the developing countries. He hypothesized that the less than dramatic increase in the growth of the processing sector in the developing countries was due partly to the low processing margins in the European Economic Community (EEC) and the United States. With the change in tariff policy, the original margins created an opportunity for large increases in processing of cocoa beans in both the US and EEC. The elimination of export taxes scenario also produced counterintuitive results, specifically while all other countries showed negative export revenues due to the change in policy, Cameroon and Ghana showed increases in export revenue. This result suggests that the export tax was encouraging inefficient processing and discouraging domestic raw bean production. With the elimination of the tax, revenue increased due to an increase in exports of raw beans and movement away from the less efficient processing and exportation of processed cocoa products. Overall, the scenarios in both cocoa and soybeans provided conflicting results, indicating less than hypothesized adjustments in processing between developed and developing countries due to the removal of tariffs.

Many authors have also used a partial spatial equilibrium model to examine changes in prices and flow of commodity due to a change in trade policy (Bates and Schmitz 1969, Zusman *et al* 1969). Wailes *et.al* (2004) also chose to use a partial, spatial equilibrium model to analyze the effects of import tariff escalation on the United States and global rice trade and prices, specifically focusing on trade between the United States and Latin American countries. The authors used the RICEFLOW© model to maximize the net monetary social welfare to make comparisons of the effects on tariff removal. Through the use of 2002 trade flow and tariff data, the authors simulated two trade scenarios and compared the results to a baseline scenario (Table 3.3).

The results of scenario one indicate that harmonization at higher tariff level has a higher overall negative effect on exports and production in the exporting countries than the import tariff escalation policy. Analysis on a country level indicates that the U.S. rice millers would be the only beneficiaries of a change in policy, as less paddy rice is exported and thus must be milled in-country for domestic consumption. Although the aggregated results indicate no change in consumption of importing countries, consumers in Nicaragua and Guatemala would be worse off from decreased imports of paddy rice which is not supplemented by increased import levels of milled rice. The aggregated results of the second scenario are compatible with hypothesized theory that the removal of escalating import tariffs lead to increases in production and exports in the exporting countries, while consumption increases in the importing countries due to lower trade barriers.

Table 3.3: Results, Wailes et al (2004)

	Importers	**Exporters**
Scenario 1: *Harmonization at the milled rice tariff level*		
Consumption	No Change	Increase
Production	No Change	Decrease
Total Trade	Decrease	Decrease
Scenario 2: *Harmonization at zero tariff level – free trade*		
Consumption	Increase	Decrease
Production	Decrease	Increase
Total Trade	Increase	Increase

Source Wailes *et al* (2004), see for detailed results

3.2.4 Other Economic Based Methods

Production Economics

Authors have chosen different methods besides examining the effects of import tariff escalation on a country through the use of ERP, nominal tariff wedge analysis, or partial equilibrium analysis. Guha-Khasnobis (2004) conducted research based on the continual complaints originating from developing countries that tariff reductions in developed countries suggested under the Uruguay Round Agreement were not uniform. More specifically, developing countries argued that there were large variations in reductions throughout different production chains and among the different importing countries. The author analyzed the impact of import tariff escalation by measuring the changes in factor prices, specifically wages, through the use of a simple production and trade model. Guha-Khasnobis chose wage as the primary measurement to illustrate the different affects that occur on unskilled and skilled labor forces due to the removal or decrease of import tariff escalation in developing countries. The author used a two country, two good model that represented one developed and one developing country and one processed and one raw commodity.

After simultaneously solving the production and trade equations, the results indicated that if the developed country would harmonize all tariff rates (no escalation), then wages of unskilled labor would rise relative to that of wages for skilled labor. However, the author notes that institutional constraints, specifically lobbying ability of each prospective labor group, could be an unexamined cause of import tariff escalation. The author argues that if the skilled labor group has stronger organized lobbying skills than unskilled labor, the country would be more prone to having a government system that protected the service sector more than the manufacturing sector, resulting in an increase in wage for skilled labor relative to unskilled labor. Therefore, the author concludes that because of the high degree of lobbying power by skilled labor groups, attention tends to be diverted away from the benefits that would occur through de-escalation, i.e. increased wages for unskilled labor in both developed and developing countries and instead escalation of tariffs continues to protect the skilled labor in developed countries.

Industrial Organization

McCorriston and Sheldon (2004) approached import tariff escalation analysis in a different manner. The authors used a three-stage game theory approach to test their hypothesis that import tariff escalation is not the only factor excluding developing countries from access to developed country markets. Instead, the authors believed it was the structure of the market and industry that was restricting assessability to developed country markets.

Using descriptive statistics, the authors found that at the processing level in developed countries, specifically the European Union and the United States, there were high levels of market concentration. At the retailing level, the authors found high concentration levels in the European Union, however, the United States were much less concentrated.

Based on these conclusions, the authors conducted a three-stage game to measure the importance of market access and import tariff escalation. The authors found that as theory suggested, a change in tariff at one processing level had a corresponding affect on a different processing level. However, the authors concluded that the degree of impact from a tariff removal or reduction would have differing affects depending on the nature of competition, in addition to the availability of substitutes of the commodity.

3.3 South-South Import Tariff Escalation Analysis

Little analysis has been done on the use of import tariff escalation in developing countries, as most research examines the effects developing countries encounter when import tariff escalation is used to block access to developed country markets. What little analysis is available examining the effects of import tariff escalation by developing countries focuses on the issue of south-south trade through nominal tariff analysis and partial equilibrium models. Even fewer studies have examined the impact on prices and quantities traded due to the application of escalating import tariffs.

Safadi and Yeats (1993) illustrate, through the nominal tariff approach, that import tariff escalation is not only a north-south problem but also a south-south trade problem. The authors analyzed data from 1970 to 1990 on 48 commodities, which were aggregated into four categories of agriculture materials, food/feeds, ores/metals, and energy products. They examined countries in Asia because the region provided a mix of developed and developing countries. Fifteen countries were selected and aggregated into South Asia, non-OECD East Asia, OECD East Asia or OECD Asia categories. The authors then used the European Economic Community (EEC) as the baseline for the analysis.

The authors concluded that overall the Asian countries are more biased against processed products when compared to the European Economic Community. More specifically, the authors concluded that Asian countries are more biased against processed commodities in intra-regional trade as compared to non-regional markets. They also concluded that between 1970 and 1990 the data showed no evidence of a narrowing of the bias when compared to the EEC data.

Based on these results, the authors examined the average import tariffs for both primary and processed products for ten selected countries. They found that countries differ greatly with applied tariffs, but that import tariff escalation occurs to some degree in almost all of the processing chains, with Japan having the highest percentage (90 percent) of processing chains with import tariff escalation. The authors conclude that import tariff escalation in Asian markets has a restrictive effect on intra-regional trade of processed goods. As a result, Safadi and Yeats, concluded that import tariff escalation is not just a north-south problem, as suggested in the Tokyo and Uruguay trade negotiation rounds, but also a south-south problem.

Laird and Yeats (1987) used the UNCTAD trade policy simulation model, which is a partial equilibrium model to estimate changes that would occur from the elimination of import tariff escalation in a variety of developing countries on some fifteen different commodities, which were aggregated into broad categories. Before conducting their analysis, the authors noted that a high degree of import tariff escalation was evident in developing countries. Where escalation was not present, the authors determined it was partly due to the lack of production capacity of the unprocessed commodity and partly due to the fact that non-tariff barriers were present in the absence of tariffs.

Using the preferential trade agreement tariff structure, which allows commodities from developing countries to enter a country with no applied import tariff as the baseline, the authors ran the UNCTAD under different scenarios of supply elasticities. Under the first scenario, of perfect elasticity, the authors found that free trade led to an increase of 6 percent in values of exchange, with an average increase of 1.4 percent in imports. Under the second scenario, unitary elasticity, the results were less than desired, however, the estimated prices still remained 10 percent above 1981 prices.

Valenzuel *et al* (2004) used a standard computable general equilibrium model to measure the changes in welfare on smallholder livestock producers in eight developing countries, including Mozambique. Their main objectives were to determine the impacts on overall income, income distribution, and poverty from the removal of tariffs in both developing and developed countries. They simulated the changes in tariffs through the use of a global trade model created by the World Bank, GTAP. The authors considered both short and long term effects from the removal of the tariffs and found that the majority of the countries had a decrease in overall poverty levels, both in the short and long run, from the removal of the tariffs, with the exception of the Philippines in the short run and Zambia, with no change in the long run.

3.4 Conclusion

This chapter has provided a detailed discussion of past research on the analysis of import tariff escalation, including detailed methods used to analyze import tariff escalation, limitations to the methods, and results obtained from the research. Using the information found in this prior research, the next chapter will provide an in-depth theoretical discussion of the chosen method for modeling import tariff escalation in trade of maize and maize flour between Mozambique and South Africa.

4. SOCIAL WELFARE MAXIMIZATION

4.1 Introduction

There are a variety of methods used to conduct analysis of import tariff escalation. Nominal wedge and Effective Rate of Protection are two specific methods previous researchers have used to examine import tariff escalation. As noted in Chapter 3, however, the disadvantages of these types of measurements outweigh the advantages. Linear programming has been extensively used in analysis of policy, but, the design of the model does not allow the price mechanism to simultaneously change production and consumption. To overcome this restriction, many researchers have used nonlinear quadratic programming models that permit for simultaneous interaction between production and consumption, specifically in general and partial equilibrium models (Durand-Morat and Wailes 2003).

General equilibrium models, such as computable general equilibrium models (CGE), permit the simultaneous interaction of all actors in the system, including producers, consumers, importers, exporters, government, etc. The data intensity of this approach and the difficulty of identifying individual effects in such a large and complex data set often lead researchers to consider partial equilibrium models (Durand-Morat and Wailes 2003).

Partial equilibrium models permit researchers to focus on a specific commodity and examine changes that occur in that market due to changes in policy or other factors. In addition, partial equilibrium models are easier to manipulate and understand. Partial equilibrium models are not without their faults, including the lack of interaction between the commodity being examined and the substitute or complement the products (Durand-

Morat and Wailes 2003). Though this limit of only examining a specific commodity in a domestic or international relationship is a disadvantage, it is appropriate for the problem examined in this research.

4.2 Conceptual Model

A spatial, price equilibrium model is the foundation for this research. Spatial equilibrium models permit separate changes in prices over geographic areas or time periods. Specifically, this type of model examines inter-regional trade and spatial efficiency of regional prices and can range from a two-country, one-commodity model to a complex multi-country, multi-commodity model. Spatial equilibrium models have its weaknesses, including the assumptions of homogeneity of all commodity types or that the production or consumption of all commodity types occur at a given location in the region. In addition, traditional relationships between buyers and sellers are ignored, and the assumption that the decision to export the commodity is based solely on a chosen optimization rule is made. Despite these limitations, it is still believed that the spatial equilibrium model is the best method to measure social welfare in this situation due to separation of commodities along the processing chain and distinctions between the producing and consuming regions, along with the required data set (Tomek and Robinson 1977).

This research will be a single-commodity spatial partial equilibrium model[11]. Myers (2008a) outlines the general model, created by Takayama and Judge (1971), by

[11] From this point forward, the spatial, partial equilibrium model used in this analysis will be referred to only as a spatial equilibrium model with the acknowledgement that this model is also a partial equilibrium model.

assuming that there are two or more countries, trading two or more homogenous goods where each country has its own separate market, with the markets being reachable through transportation. The exporting country, *i*, has a supply equation, q_i^s , that is a factor of input prices and a demand equation, q_j^d , for the importing country, *j*, is a factor of product prices, which are maximized less transportation, *c*, of the product (equation 4.1). In addition, the following constraints are included: (1) that the quantity demanded is less than or equal to total imports, x_{ij} , in the importing region, (equation 4.2) and (2) that the quantity exported to all other regions is less than or equal to the quantity supplied in the exporting region (equation 4.3).

(4.1) $$\max\left\{\sum_{j=1}^{n}\int_{0}^{q_j^d} D_j(q_j^d)dq_j^d - \sum_{j=1}^{n}\int_{0}^{q_i^s} D_i(q_i^s)dq_i^s - \sum_{i=1}^{n}\sum_{j=1}^{n} c_{ij}x_{ij}\right\}$$

(4.2) $$\sum_{i=1}^{n} x_{ij} \geq q_i^d$$

(4.3) $$\sum_{j=1}^{n} x_{ij} \leq q_j^s$$

Takayama and Judge (1971) state that if the supply and demand functions do not fulfill the symmetry assumption[12], then the condition that allows for integrals to be used is not met, and therefore, one is not able to construct a quasi-welfare function to

[12] Myers (2008) explains that when expenditure functions are well define in that $\frac{\partial^2 e(p,u^0)}{\partial p_i \partial p_j} = \frac{\partial^2 e(p,u^0)}{\partial p_j \partial p_i}$ it thus implies that $\frac{\partial x_i^h(p,u^0)}{\partial p_j} = \frac{\partial x_j^h(p,u^0)}{\partial p_i}$, therefore meaning that the Hicksian cross price effects are symmetric.

maximize. In reality, most estimated supply and demand equations do not meet the symmetry condition. Therefore, the authors explain, by moving from a welfare-orientated model to a net social monetary concept allows for asymmetry. The net social monetary welfare measure thus becomes total social revenue less total social production cost, less transport cost. This spatial equilibrium model is subject to material and price constraints special to this model, including no excess demand or profit in the regions.

This research will be based on the economic theory of social welfare maximization as the measurement tool to analyze the changes that occur under different import tariff escalation and VAT scenarios in Mozambique. Using the basic spatial price equilibrium model (equation 4.1) as a template, Durand-Morat and Wailes (2003) create a spatial equilibrium model that uses quadratic programming to maximize total social welfare (equation 4.4), subject to price constraints (equation 4.5) and material balances (equations 4.6 and 4.7) where all prices and export quantities must be greater than or equal to zero. The price constraints maintain that price differences between the importing and exporting countries must be less than or equal to the total cost of transport and tariffs, while the material balance equations require that total exports be equal to the excess quantity demanded in the importing country and total imports be equal to the excess quantity supplied in the exporting country.

(4.4)
$$MaxZ = \sum_{yi}\left(\alpha_i^y CIF_i^y - \frac{1}{2}\beta_i^y (CIF_i^y)^2\right) - \sum_{yj}\left(\gamma_j^y FOB_j^y - \frac{1}{2}\beta_j^y (FOB_j^y)^2\right) - \sum_{yji}\left(TC_{ji}^y \cdot X_{ji}^y\right)$$

(4.5)
$$CIF_i^y - FOB_j^y \leq TC_{ji}^y + \left(T_{ji}^y \cdot X_{ji}^y\right)$$

(4.6) $$\sum_j \left(X_{ji}^{y}\right) = \alpha_i^y - \beta_i^y CIF_i^y$$

(4.7) $$\sum_i \left(X_{ji}^{y}\right) = \gamma_j^y + \delta_j^y FOB_j^y$$

Table 4.1: Variables Description for Durand-Morat and Wailes (2003) Welfare Model

Variable/Parameter Description			
α	Excess demand intercept	M	Import quantity
β	Excess demand slope	X	Export quantity
γ	Excess supply intercept	E_S	Domestic elasticity of supply
δ	Excess supply slope	E_d	Domestic elasticity of demand
FOB	Price in the exporting country	E_{esj}	Excess supply elasticity
CIF	Price in the importing country	E_{sdi}	Excess demand elasticity
TC	Transport cost	*QD*	Quantity demanded
T	Tariff	*QS*	Quantity supplied

Subscript Description			
i	Importing Country	*j*	Exporting Country
y	Commodity type		

Price elasticities of excess demand and excess supply are required to calculate the intercepts and slopes of the excess supply and excess demand curves of a country in the world trade market to make the model operational. Koo and Kennedy (2005) and Durand-Morat and Wailes (2003) provide the general outline for calculating linear excess supply and demand elasticities (equations 4.8 and 4.9). The excess supply and demand elasticities are calculated through the use of domestic supply and demand elasticities, domestic production and consumption, and exports or imports dependent on the country.

(4.8) $$E_{esj} = E_{sj}\left(\frac{QS_j}{X_j}\right) - E_{dj}\left(\frac{QD_j}{X_j}\right)$$

(4.9) $$E_{edi} = E_{di}\left(\frac{QD_i}{M_i}\right) - E_{si}\left(\frac{QS_i}{M_i}\right)$$

Once excess demand and supply elasticities are calculated, intercepts and slopes of the excess supply and demand curves can be calculated through the manipulation and substitution of the price dependent equation of excess supply/demand and excess supply/demand elasticity. Equation 4.10 shows the price dependent equation for supply, which is used to create the slope (equation 4.11) and the intercept (equation 4.12) for the excess supply curve. Equation 4.13 to 4.15 illustrate the same equations for the excess demand curve.

(4.10) $FOB_j = \gamma_j + \delta_j X_j$

(4.11) $\delta_j = \frac{FOB_j}{X_j^y} \cdot \frac{1}{E_{esj}}$

(4.12) $\gamma_j = FOB_j - \delta_j X_j$

(4.13) $CIF_i = \alpha_i + \beta_i M_i$

(4.14) $\beta_i = \frac{CIF_i}{M_i} \cdot \frac{1}{E_{sdi}}$

(4.15) $\alpha_i = CIF_i - \beta_i M_i$

4.3 Conclusion

This chapter has outlined the theoretical reasoning for the use of a spatial equilibrium model for this research and provided examples of general maximization equations used to measure the difference in social welfare that occurs under different import tariff policies. For the model to be made operational, domestic supply and elasticities must be estimated so that they can be used to calculate the excess supply and demand elasticities for the regions. The following chapter provides the conceptual and empirical models used in the domestic elasticities estimations, in addition to descriptions of the data used and the results found.

5. ECONOMETRIC ESTIMATES OF DEMAND AND SUPPLY

5.1 Conceptual Model

To calculate the change in net social monetary welfare due to a change in import tariff policy, individual demand and supply elasticities must be estimated for each region. Traditional demand estimation is based on the economic theory of consumer behavior, which maximizes consumer utility subject to price constraints. At the most general level, demand for a product is the function of the price of that product, the price of substitutes for the given product, and income of the consumer group (equation 5.1). Throughout the years, consumer demand theory has evolved to include additional information pertaining to the consumer, including, but not limited to, changes in tastes and preferences, age, sex, and ethnic background (Ferris 1998).

(5.1) $$QD = f(Y, P_i, P_j \ldots P_{z,})$$

Supply estimation, on the other hand, is based on the economic theory of the firm in which supply is determined through the first order conditions of profit maximization. In its simplest form, supply is a function of input and output prices (equation 5.2). However, as with demand, supply estimation has evolved, specifically in agriculture supply response, to include supply shifters such as weather, technology changes, institutional constraints and prices of substitute or complement commodities. Additionally, Ferris (1998) notes that due to the biological lags in production, expected prices tend to be more important than current prices in production decisions. The uncertainty of expected prices is addressed through the increased use of forward contract markets and futures.

(5.2) $$QS = f(P, v, w)$$

When estimating supply and demand equations, researchers tend to assume that prices and quantities are determined simultaneously, and are therefore endogenous. To account for this endogeneity, researchers typically use a system of simultaneous equations that include an instrumental variable that eliminates the endogeneity between the variables.

Tomek and Robinson (1977) contended that this theory is only relevant if sufficient time is allowed to pass to develop interdependence between price and quantities. If this interdependence is not established, either through a short observation period or long time lags between changes in variables, then prices and quantities are determined sequentially.

Due to the nature of agricultural supply and the use of expected prices and futures for supply decisions, in addition to the anticipated short data observation available due to the location of the study, this research will use the Cobweb Model to estimate demand and supply. Tomek and Robinson (1977) note that this recursive model permits no feedback from shocks to the system. Shocks, such as drought, are felt down the system to quantity supplied, but never move back up the system to effect prices for the following year. This in turn means that none of the explanatory variables are endogenous or correlated with the error term, allowing for the use of ordinary least squared (OLS) regression.

Tomek and Robinson (1977) note that the Cobweb model is based on five assumptions, which are generally the source of criticism. The assumptions are as follows: (1) producers are price takers and their supply decisions are based upon price; (2) when price changes there is a clear time lag between the initial price change and when that change is seen in production; (3) the quantity of product that producers planned to be produced is the actual quantity produced; (4) no storage is used as the quantity produced in a marketing year is completely sold in the same marketing year and thus determines the price of the product in that marketing year, and (5) supply and demand are both linear functions that do not shift.

For this study, the first assumption holds, as producers in both South Africa and Mozambique are world price takers. Specifically in Mozambique, the majority of production decisions are based on past price information due to the lack of futures markets. The second assumption holds as a change in price cannot influence production decisions until the following production season, as the majority of maize is planted once a year in both of these production regions. Assumption four holds true in Mozambique, where there is little maize storage and most of the maize produced is sold within the marketing year.

In general, Tomek and Robinson (1977) note that the problem with the model is that there is little confidence that the planned production of a commodity is the amount that is produced in the end (assumption 3). If there is a random shock that occurs before the cycle has been completed, such as a drought, it equates to a shift in supply and leads to a start of another cycle. This random shock can either speed up the rate at which the cycle converges to equilibrium or prolong the time spent to reach equilibrium, therefore violating assumption three. However, based on the general assumptions made, this model complements the regions being examined. In addition, this model is less data intensive, which is important as data availability are expected to be an issue.

5.2 Empirical Model, Data and Results

Using time series data, individual demand for flour in all three regions will be estimated to obtain own price elasticities of demand, in addition, individual supply of maize grain to obtain the own price elasticity of supply for grain. As noted above, the Cobweb Model is being used to avoid endogeneity between prices and quantities and thus eliminating the need to estimate these equations simultaneously.

A log-log OLS model was used in both supply and demand estimation for all three regions. This was done because the desired information from the model is the estimated elasticities and a log-log model provides estimates of elasticities, allowing for ease of interpretation of the results. In addition, a log-log model is appealing because it can reduce the influence of outliers and correct, for the distribution of the variables.

5.2.1 Southern Mozambique –Demand for Maize Flour

5.2.1.1 Model

Demand for maize flour for southern Mozambique was estimated using the econometric model below (equation 5.3), where demand is a function of retail maize flour price (CP_{st}^{f}), retail rice price (CP_{st}^{r}), and a time trend (T). A time trend was used in place of production GDP per capita for two reasons. First, due to the manner in which consumption of maize flour was created, specifically the use of expenditure GDP in the calculation of maize flour consumption, the GDP variables and the consumption variable are highly (greater than 80 percent) correlated. Second, due to the unusual GDP growth patterns discussed in Chapter 2, such as periods of large growth rates during the post-war growth and years of low to negative growth rates due to poor production seasons, a time trend was found to be a better explanatory variable than GDP[13]. In addition, the unavailability of regional GDP per capita does not allow for variation between regions in a country that is drastically different (lifestyle, consumption and production patterns, labor) by region.

(5.3) $$\ln QD_{st}^{f} = \beta_0 + \beta_1 \ln CP_{st}^{r} + \beta_2 \ln CP_{st}^{f} + \beta_3 T + \mu_t$$

5.2.1.2 Data

For this time series analysis of demand of maize flour in southern Mozambique, all observed data are from the years 1992 to 2006. All observed prices have been deflated to the 2004 new Meticals, using a non-food CPI deflator (Donovan, 2008) due to the high expenditure allocated to food in the all items CPI and the invalid weighting that occurs when deflating prices using a CPI deflator that is highly weighted in that category. All quantities have been converted to kilograms (kg).

Quantity Demanded – Flour (QD^{f})

Consumption of maize flour in southern Mozambique was not available. Therefore, consumption of maize flour for the data time series was calculated based on 1996 expenditure (IAF, 1996), per capita expenditure GDP (INE, 2008), maize flour prices (SIMA, 2008) and total population of the regions (INE, 1997).

Before an average weighted expenditure can be calculated, a weighted population must be calculated using INE population provincial estimates and 1997 provincial urban

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[13] Structural change due to post war economic growth was attempted to be controlled, however, due to the lack of observation points and 'normal' growth years, accounting for structural change did not stabilize the variable.

and rural breakdowns from a national census. Using the weighted population estimates, an average weighted static expenditure for the southern regions of Mozambique was calculated using 1996 expenditure data (equation 5.4). Although not ideal, the expenditure on maize and maize derivatives for 1996 was used across all time series points due to lack of data available on expenditure for other years. After a weighted expenditure for the southern region of Mozambique was calculated, expenditure GDP per capita, the retail price of maize flour and total population for the south were used to estimate the total consumption of maize flour for southern Mozambique (equation 5.5).

(5.4)

$$EXP_r^w = \sum \left\langle \left[\left(PPOP_p^{urban} \cdot 96EXP_p^{urban} \right) + \left(PPOP_p^{rural} \cdot 96EXP_p^{rural} \right) \right] \cdot \frac{POP_p}{POP_r} \right\rangle$$

(5.5)

$$QD_{t,r}^{pc,f} = \left(\frac{GDP_{t,r}^{pc} \cdot EXP_r^w}{CP_{t,r}^f} \right)$$

Table 5.1:Parameter Description for Maize Flour Consumption Calculation

Variable/Parameter	**Description**		
EXP	Expenditure	*POP*	Population
96EXP	Percent Expenditure from 1996	*PPOP*	Percent Population
GDP	Gross Domestic Product	*CP*	Retail Price
CON	Consumption		

Subscript	**Description**		
w	Weighted	*r*	Region
p	Province	*f*	Flour
urban	Urban	*rural*	Rural
pc	Per capita		

Note: See Appendix C for a more detailed description.

The limitations of this method of creating the quantity consumed of maize flour should be acknowledged. Specifically, the 1997 percentage of urban and rural population are likely not consistent with the percentage of population in rural and urban areas throughout the entire time series. In addition, using an expenditure that includes maize and maize derivatives, almost undoubtedly skews the consumption of maize flour upwards. However, both the urban and rural breakdown and the expenditure percentage of maize and maize derivatives were the best available information.

Maize Flour Price (CP^{f})[14]

In southern Mozambique, price data for maize flour was reported on a weekly basis from specific markets throughout the region provided that the commodity was available at the market (SIMA, 2008). The maize flour prices from the Maputo City markets were used. Observed prices from multiple markets within Maputo City that occurred on the same date, were combined to create aggregate daily Maputo maize flour prices, which were then aggregated to create monthly prices. Finally, using the Mozambique maize marketing year of April to March, observed prices were combined to create a yearly time series data set of maize flour prices.

Price of Rice (CP^{r})

The retail price of milled rice is used as the main substitute for maize flour in the southern region. Retail milled rice prices were also reported on a weekly basis from selected markets when the commodity was available (SIMA, 2008). To create

[14] Due to the nature of prices, all prices for all elasticity estimations were tested for unit roots. The test results and discussion can be found in Appendix B.

consistency of reporting across retail prices, Maputo City market prices were again used for the southern Mozambique region. Rice prices were aggregated in the same manner as the maize flour prices, first daily, then monthly and finally a time series of yearly rice prices for the maize marketing year of April to March was created.

Time Trend (T)

Economic variables have a tendency to change over time and this increase cannot always be accounted through measurable explanatory variables. Thus, a time trend is included to capture the effect of the increase. In this case, if the coefficient is positive, consumption of maize is increasing over time, if it is negative, consumption of maize flour is decreasing over time. The time trend in this particular demand estimation is hypothesized to account for changes in tastes and preferences and income.

5.2.1.3 Results

The estimated demand of maize flour results for southern Mozambique are outlined in Table 5.2. The model indicates that the explanatory variables explain the variation in consumption well with an R^2 of 90 percent. In addition, the regression has explanatory power with a probability value of the F-statistic of 0 percent. All coefficients on the explanatory variables are also consistent with economic theory.

Table 5.2: Southern Mozambique Demand Estimation

Dependent Variable = Consumption of Maize Flour, kgs/capita			
Explanatory Variable	Coefficient	T-Stat (P-Value)	Significance
Price of Maize Flour, Meticals/kgs	-0.89	-7.18 (0.0)	***
Price of Rice, Meticals/kgs	0.21	1.21 (0.26)	
Time Trend	0.03	2.12 (0.06)	*
Constant	5.08	18.47 (0.0)	***
F-Stat	30.27		
Prob >F	0.000		
R-squared	0.9008		

Source: Estimated from secondary data source
Note: Number of observations 14. All estimates in log-log form.
* Significance at the 10 percent level
** Significance at the 5 percent level
*** Significance at the 1 percent level

However, the high R^2 (a classic sign of multicollinearity), the manner in which per capita consumption of maize flour was created, and the general nature of the data could be the indication of estimation problems. First, multicollinearity was assumed to be present in the model and a correlation matrix indicated a high correlation between the dependent variable of maize flour consumption and the explanatory variable of maize flour prices, but, correlation between the explanatory variables remained under 50 percent. The presence of multicollinearity results in large standard errors that cause coefficients to be sensitive to small changes within the sample. Multicollinearity can only be corrected through the removal of one of the correlated variables, which can result in estimations not consistent with economic theory and have other major implications for the econometric model. Therefore, acknowledgement of the sensitivity of the estimated parameters needs to be made.

In addition, the estimated parameters are sensitive to change due to the small data sample, which are undesirable in econometric estimation. Goldberger (1991) states that micronumerosity, small sample size, creates the same problems as data sets with multicollinearity, including high standard errors relative to the coefficients, therefore causing coefficients to be highly susceptible to small changes within the sample. Goldberger suggests that estimation should be reconsidered if more observations are not available. However, this research acknowledges the sensitivity of the parameters used from the estimation results by conducting sensitivity tests that are reported in Appendix D.

Heteroscedasticity, which causes the variance of the error term to be inconsistent across all observations, was tested for through the use of the Breusch-Pagan-Godfrey Test. The null hypothesis that heteroscedasticity was not present in the model was unable to be rejected at a 5 percent level. Due to the presence of heteroscedasticity, the variables in the model are biased and inconsistent (Hamilton, 1994).

Autocorrelation, which causes the covariance between different observations to not equal zero, was tested for with the Durbin-Watson Test. The Durbin-Watson test statistic was found to be in the indeterminate zone between the upper and lower bound statistics, failing to reject the null hypothesis that there is no first order autocorrelation in the model. Due to the autocorrelation in the model, the standard error terms are inconsistent and biased (Hamilton, 1994).

To correct for both heteroscedasticity and autocorrelation, White's Robust Standard Error Estimation was used. Unfortunately, as Hamilton (1994) notes, this correction only adjusts the variances, not the parameter estimates. With a large sample this would not be a concern, as the loss of efficiency in the parameters would be minimal. However, with a small sample size the efficiency loss in the parameters is greater. Again sensitivity analysis on the elasticities and comparison of previously reported elasticities will be used to validate the estimated elasticities.

As expected, the own-price elasticity of demand for maize flour is inelastic. However, it is more inelastic than one might expect due to its importance as a consumption staple in Mozambique. Consumption of maize flour decreases by .89 percent when there is a 1 percent increase in maize flour price. However, the shift of relative prices of maize flour as compared to rice (Figure 1.1) and a general shift of preferences in the south, particularly the urban areas, for rice could be the source of the highly sensitive own-price elasticity of maize flour. The cross-price of rice, although not statistically different from zero, does indicate that rice is a substitute for maize flour but little adjustment of consumption of maize flour is made when the price of rice increases. More specifically, with a 1 percent increase in rice prices, consumption of maize flour only increases 0.2 percent. However, the coefficient on the time trend does not correspond with the hypothesized change in preferences, as consumption of maize flour is increasing by 0.03 percent with each passing year.

These conflicting results could be due to the manner in which the dependent consumption of maize flour variable was created and the resulting multicollinearity, in addition to the sensitivity of the parameters due to the small sample size. Comparison to ARMA model estimates (Appendix B) and sensitivity tests were conducted on the own-price elasticity of maize flour (Appendix D), and it was determined that -0.87 would be used as the own – price elasticity in the net social monetary welfare maximization equation.

5.2.2 Southern Mozambique – Supply of Maize Grain

In the southern region of Mozambique, supply elasticity is assumed to be zero and was not estimated. Estimation was not done due to the southern region being classified a consumption zone, its minor contribution to national production (Table 2.1), and the lack of producer prices reported by SIMA (2008). In addition, poor overall soil quality and high variability in rainfall during the production months create a situation where it is hypothesized that southern producers plant available land regardless of the price. However, Cruz (2006) used an assumed supply elasticity for maize in the south of 0.3 percent. Therefore, sensitivity tests were conducted and it was determined that 0 percent would be used as the supply elasticity in the social welfare model (Appendix D).

5.2.3 Central Mozambique – Demand for Maize Flour

5.2.3.1 Model

Equation 5.6 was used to estimate central Mozambique's demand for maize flour. Demand was estimated as a function of retail maize flour price (CP_{ct}^{f}), retail rice price (CP_{ct}^{r}), and a time trend (T). As discussed in section 5.2.1.1, a time trend was used in place of GDP[15] per capita due to the nature in which maize flour consumption was calculated and the uncontrollable characteristics of GDP in Mozambique.

(5.6)
$$\ln QD_{ct}^{f} = \beta_0 + \beta_1 \ln CP_{ct}^{r} + \beta_2 \ln CP_{ct}^{f} + \beta_3 T + \mu_t$$

[15] Again attempts to stabilize the variable through the use of dummy variables at the points of structural change were attempted, however, the variable could not be stabilized due to the lack of 'normal' growth data points of the GDP data set.

5.2.3.2 Data

The central Mozambique time series data set for the demand estimations was for the years of 1992 to 2006. Quantities have been converted in kilograms (kg). Using the same non-food CPI deflator (Donovan, 2008), the prices observed in the center region have been deflated to 2004 new Meticals.

Quantity Demanded – Flour (QD^f)

Consumption of maize flour for central Mozambique was not available. Using the same method explained in the data section for the demand of maize flour for southern Mozambique (5.2.1.2), consumption of maize flour was calculated using a static weighted 1996 total expenditure allocated to maize and maize derivatives for the central region that was applied to yearly expenditure GDP, which was then divided by the price of maize flour in the central region (equation 5.4 and 5.5). The limitations to the method of calculation still remain, including the use of static expenditure percentages (1996) and static urban and rural breakdowns (1997), due to data availability this is the best method that could found.

Maize Flour Price (CP^f)

As in the southern region, prices were reported on a weekly basis when the commodity was available in selected markets throughout central Mozambique (SIMA, 2008). Beira was chosen as the best representative market for retail maize flour prices in central Mozambique and thus prices from the Beira markets were aggregated first by daily observations from multiple markets with the Beira classification then by month, and finally by year to create an average yearly price for the Mozambique maize marketing year of April to March.

Price of Rice (CP^r)

As in southern Mozambique, rice is the main substitute for maize flour. Retail milled rice prices from selected markets throughout Beira were selected as the main market for price analysis to eliminate inconsistencies due to location (SIMA, 2008). Prices were aggregated in the same manner as maize flour to create a yearly retail rice price.

Time Trend (T)

To create consistency throughout the country of Mozambique, a time trend was used in central Mozambique, as in southern Mozambique, to capture the increase in consumption of maize flour over time. Specifically, the time trend was used to capture the changes in preferences and tastes in addition to the income effect that was not captured due to omitting GDP per capita as an explanatory variable

5.2.3.3 Results

Table 5.3 shows the results of the estimated demand for consumption of maize flour in central Mozambique. The model had an R^2 of 66 percent and was overall significant in modeling the consumption of maize flour at a 1 percent significance level.

Table 5.3: Central Mozambique Demand Estimation

Dependent Variable = Consumption of Maize Flour, kg/capita			
Explanatory Variable	Coefficient	T-Stat (P-Value)	Significance
Price of Maize Flour, Meticals/kg	-0.33	-0.88 (0.40)	
Price of Rice, Meticals/ kg	0.21	0.36 (0.72)	
Time Trend	-0.024	-0.67 (0.52)	
Constant	4.578	4.48 (0.0)	***
F-Stat	7.11		
Prob >F	0.0045		
R-squared	0.6596		

Source: Estimated from secondary data source
Note: Number of observations 15. All estimates in log-log form.
* Significance at the 10 percent level
** Significance at the 5 percent level
*** Significance at the 1 percent level

As with the demand estimation in southern Mozambique, multicollinearity was suspected to be present within the explanatory variables due to a high R^2 and insignificant t-statistics on the explanatory variables. A correlation matrix indicated high correlation (77 percent) between the time trend variable and the retail price of rice. The time trend and dependent consumption variable were also correlated at 75 percent. The presence of multicollinearity combined with a small sample size, which results in similar negative effects as multicollinearity, again equates to estimated coefficients that are highly sensitive to change within the sample.

The equation was tested for heteroscedasticity using the Breusch-Pagan-Godfrey Test. Again, the results failed to reject the null hypothesis that the model was homoscedastic. The Durbin Watson Test was used to test for first order autocorrelation. It was found that at a 95 percent confidence level, the null hypothesis was accepted and there was not autocorrelation in the model. The model was corrected for heteroscedasticity through the Whites Robust Standard Error correction, however, again only standard errors were corrected not parameter estimates, and thus the parameter estimates have a loss of efficiency due to the small sample size.

Although most variables were consistent with economic theory, none of the explanatory variables were significantly different from zero. A time trend was used in place of GDP for reasons previously explained in section 5.2.1.1, however, the model now indicates that consumption of maize flour is decreasing overtime, which is not indicative of current consumption trends in central Mozambique. Additionally, when modeled with a time trend, the own-price and cross price elasticities were not significantly different from zero. Although, own-price elasticity of maize flour was relatively inelastic, which one would hypothesize to be correct, a decrease in consumption of 0.33 percent due to a 1 percent change in price may be low when compared to other estimates of demand elasticities. Due to the sensitivity of the parameters from the multicollinearity, small sample size, and heteroscedasticity, sensitivity tests were conducted on the own-price elasticity of maize flour for central Mozambique (Appendix D) and comparison with ARMA elasticity estimates (Appendix B), which resulted in -0.33 own-price elasticity of demand for maize flour to be used in the net social monetary welfare maximization equation.

5.2.4 Central Mozambique – Supply of Maize Grain

5.2.4.1 Model

Supply of maize grain in central Mozambique was estimated as a function of a one period lagged producer price (PP_{t-1}^{g}), rainfall (TTR_{ct}), and a time trend (T) (equation 5.7). Futures prices were not available for Mozambique, so it was determined that the price of grain lagged one year would be the best indicator for expected prices for farmers, which is consistent with the habits of

Mozambique producers. Rainfall data were used as the main input variable since fertilizer and irrigation are rarely used. Additionally, a time trend was added to account for changes in production of maize grain in the region.

(5.7) $$\ln QS_{ct}^{g} = \beta_0 + \beta_1 \ln PP_{t-1}^{g} + \beta_2 \ln TTR_{ct} + \beta_3 T + \mu_t$$

5.2.4.2 Data

A time series data set from 1993 to 2006 was used to estimate the maize grain supply for central Mozambique. As with all other time series data, quantities have been converted in kilograms (kg) and prices have been deflated to 2004 Meticals using the non-food CPI deflator (Donovan, 2008).

Quantity Supplied – Grain (QS^{g})

Regional total maize production was not available for the entire time series and thus had to be calculated for some years. Total production for the years to 1993 to 1999 was obtained from the FAO. INE provided total production from 2000 to 2002 and the FEWSNET Food Balance Sheets provided regional production for the remainder of the time series.

To create regional production numbers for data from 1992 to 2002, the 2006/2007 regional production breakdown (37 percent) was applied to all yearly total production. Although actual regional production numbers would be ideal, the 2006/2007 production year appears to be a consistent with regional production patterns when compared to the regional production patterns from 2003 to 2005 provided by the FEWNET Food Balance Sheets, in addition to production patterns found in the 2002 IAF household survey (2002).

Lagged Producer Price (PP^{g}_{t-1})

The producer prices reported for the province of Manica were used in place of Chimoio, the largest production region in the center, due to lack of data availability in Chimoio (SIMA, 2008). Only prices reported from May through October were used, since that is the typical period producers sell maize. Prices were first aggregated by all prices reported on a specific date, then within a month and finally into the maize marketing year of April to March and then lagged one year.

Total Rainfall (TTR)

Total rainfall was reported on a ten days basis throughout the production year (September to April) for different locations throughout Mozambique (FEWNET, 2008). The central region station used was Sussundenga in Manica Province. Rainfall was summed throughout the production year to create a total rainfall variable. Rainfall data were not available for 1992 through 1994 and were thus calculated as the average rainfall throughout the years available (1995-2007) minus the standard deviation of that time period.

Time Trend (T)

Economic time series have a tendency to change over time and this increase cannot always be accounted through measurable explanatory variables. In this particular model, production steadily increases over time. The increase is hypothesized to be due to the increased political stability, but, other factors are also likely to contribute to production growth. Therefore a time trend was included to capture all the effects causing a change in maize production in central Mozambique.

5.2.4.3 Results

Table 5.4 shows the regression results for the supply of maize grain for central Mozambique. The R^2 is 81 percent and the F-value shows that the model is significant at a 1 percent level, however, many of the explanatory variables do not have statistically significant t-statistics, indicating possible multicollinearity in the model. The correlation matrix reveals that the time trend and production are correlated around 80 percent and again the estimation is done with a small sample size, therefore causing the parameters to be highly sensitive to changes in the data sample.

The estimated equation was tested for both heteroscedasticity and autocorrelation. Results from the Breusch-Pagan-Godfrey Test failed to reject the null hypothesis that the model was homoscedastic at a 5 percent significance level. The Durbin Watson Test results also failed to reject the null hypothesis that there was no autocorrelation in the model. Therefore White's Robust Standard Errors method was used to correct for both heteroscedasticity and autocorrelation in the model. As with the other models, this correction method only corrects the standard errors, however in large samples the coefficients are asymptotically normal due to the small loss in efficiency. Since this model was used on a small sample, the loss of efficiency on the parameter coefficients cannot assume to be to be asymptotical and thus the sensitivity of the parameters must be considered when interpreting the results.

Table 5.4: Central Mozambique Supply Estimation

Dependent Variable = Production of Maize Grain, kgs			
Explanatory Variable	Coefficient	T-Stat (P-Value)	Significance
Lagged Producer Price, Meticals/kg	0.17	0.88 (0.40)	
Total Rainfall, mm	0.46	1.43 (0.18)	
Time Trend	0.08	5.46 (0.0)	***
Constant	15.99	6.63 (0.0)	***
F-Stat	25.68		
Prob >F	0.001		
R-squared	0.8105		

Source: Estimated from secondary data sources
Note: Number of observations 15. All estimates in log-log form.
* Significance at the 10 percent level
** Significance at the 5 percent level
*** Significance at the 1 percent level

The estimated coefficients are consistent with economic theory, however, most are not statistically different from zero, especially the desired price elasticity of supply. Although not significant, the own-price supply elasticity indicates that as the price of maize grain increases by 1 percent, quantity of maize supplied increases by 0.17 percent. It is important to note that due to production systems throughout Mozambique, with low inputs and rain fed production, a low elasticity is not unreasonable as actual hectares planted are not always harvested. Nevertheless, the supply elasticity of maize does seems low when compared to a study by Cruz (2006) who assumed a supply elasticity in central Mozambique of 0.45 percent. Therefore, comparison to ARMA elasticity estimates (Appendix B) and sensitivity tests were conducted on this elasticity (Appendix D) and it was determined that 0.17 supply elasticity of maize in central Mozambique would be used to estimate the excess supply elasticity of central Mozambique for the net social monetary welfare maximization equation.

5.2.5 South Africa – Demand for Maize Flour

5.2.5.1 Model

Equation 5.8 shows the econometric model used to estimate the demand of maize flour in South Africa. Based on economic theory, the demand of maize flour in South Africa is being estimated as a function of the own price of maize flour (CP_{at}^{f}) and the per capita income for South Africa (GDP_{at}^{pc}).

(5.8) $$\ln QD_{at}^{f} = \beta_0 + \beta_1 \ln GDP_{at}^{pc} + \beta_2 \ln CP_{at}^{f} + \mu_t$$

5.2.5.2 Data

For the South African time series analysis of demand, all observed data are from the years 2000 to 2006. All quantities have been converted to kilograms and all prices have been deflated to 2004 and converted to Meticals. Prices in South African Rand were deflated using the urban CPI deflator (Statistics South Africa, 2008) and were converted using exchange rates at the Interbank rate (OANDA, 2008). Prices reported in U.S. Dollars were deflated using an U.S. urban CPI deflator (U.S. Department of Labor Statistics, 2008) and converted to Meticals through an U.S. dollar – Mozambique-Metical exchange rate (OANDA, 2008).

Quantity Demanded – Flour (QD^{f})

Data on consumption of maize flour in South Africa were not available. However, by using the food balance equation (equation 5.9), where the sum of production, imports, and beginning storage, equals the sum of consumption, exports, and ending storage, the disappearance method was used to determine quantity of maize flour consumed. Total maize milled per year (The National Maize Millers of South Africa, 2008), imports of maize flour and exports of maize flour per year (United Nations, 2008), and the assumption that beginning and ending storage was zero, a time series data set on consumption of maize flour in South Africa was created. Total maize flour consumption in South Africa was then divided by total population to achieve maize flour per capita (World Bank, 2008).

(5.9) $$PROD + IMPORTS + STOR_s = CONSUMP + EXPORTS + STOR_e$$

Maize Flour Price (CP^{f})

The consumer price of maize flour for South Africa was evenly aggregated for the twelve month maize marketing year in South Africa, May to April (SAGIS, 2008).

GDP per Capita (GDP^{pc})

GDP per capita, which was reported in current local currency was deflated and converted to 04 Meticals and then divided by total population to obtain a data set of GDP per capita for South Africa (World Bank, 2008).

5.2.5.3 Results

The results of the econometric estimation of demand for maize flour in South Africa are shown in Table 5.5. The model had an R^2 of 80 percent, indicating the variation in consumption was explained well by the variables in the model, and a high F-value, which implies that the regression had explanatory power. In addition, although not all significantly different from zero, the estimate coefficients for the explanatory variables were consistent with economic theory.

Table 5.5: South African Demand Estimation

Dependent Variable = Consumption of maize flour, kg/capita			
Explanatory Variable	Coefficient	T-Stat (P-Value)	Significance
Price of Maize Flour, Meticals /kg	-0.49	-1.35 (0.25)	
GDP per capita, Meticals/capita	-1.88	-3.73 (0.02)	**
Constant	26.95	4.48 (0.01)	***
F-Stat	7.19		
Prob >F	0.0474		
R-squared	0.8047		

Source: Estimated from secondary data sources
Note: Number of observations 7. All estimates in log-log form.
* Significance at the 10 percent level
** Significance at the 5 percent level
*** Significance at the 1 percent level

Originally wheat flour, the major substitute for maize flour was included in the model to capture the cross price effects. However, under further investigation, the variable was insignificant (probability of t-statistic 0.988) and highly correlated (86 percent) with GDP per capita. Therefore, it was decided to remove the variable to help decrease the multicollinearity effects, specifically parameter sensitivity, in a data set that was already more susceptible to parameter sensitivity due to the small sample size. Multicollinearity does still exist in the model as indicated in the correlation matrix between GDP and consumption of maize flour.

As with the other demand estimations, heteroscedasticity and autocorrelation were tested. The Breusch-Pagan-Godfrey Test failed to reject the null hypothesis that the model was homoscedastic at a 5 percent significance level. The null hypothesis was accepted at a 5 percent significance level in the Durbin Watson first-order autocorrelation test, indicating that the model was not autocorrelated. However, Whites Roust Standard Errors correction still had to be used to correct the standard errors due to heteroscedasticity. Due to the small sample size, the same loss of efficiency of the parameters discussed in previous estimation results still is relevant.

Although not the focus of this study, the model indicates that consumption of maize flour is expected to decrease by 1.88 percent as income increases by 1 percent in South Africa. This result is consistent with Bennet's Law, which states as a country's income increases, the proportion of income spent on staples decreases, once they reach a minimum level of income needed to meet everyday caloric needs. The own price elasticity, which indicates that consumption of maize flour will decrease by 0.5 percent as the price of maize flour increases by 1 percent, is consistent with economic theory. However, the t-statistic on this parameter indicates that it is not statistically different from zero.

It is believed that the own price elasticity is valid and would be statistically significant if additional observations were available due to its comparability to the own-price maize flour elasticity estimated by Mabiso and Weatherspoon (2008). The authors use the same data set, including time frame and retail maize flour prices, except their analysis of demand was on a monthly basis, thus increasing their sample size to over 80 observations. The authors estimate comparable own-price demand elasticities for maize flour using a seemingly unrelated regression and a double log single equation model and find in both models own-price demand elasticity for maize flour of -0.42 that is statistically significant at a 5 percent level.

5.2.6 South Africa – Supply of Maize Grain

5.2.6.1 Model

South Africa's econometric model of supply of maize grain was based on the economic theory of supply estimation discussed in section 5.1, with consideration taken for data availability and the production system in South Africa. Supply is modeled as a function of the futures price of maize grain (FPP_t^g), fertilizer prices ($FERT_t$), and a time trend (T) (equation 5.10). Futures prices were chosen to apply Ferris' (1998) belief that farm supply is based on expected prices and South Africa has an active futures market. Fertilizer was determined to be the main input used in South Africa and thus was chosen as the input price. In addition, rainfall is known to be an important variable in production, as most agriculture production is rain fed. However, after repeated attempts, rainfall data for South Africa were unavailable.

(5.10) $$\ln QS_{at}^g = \beta_0 + \beta_1 \ln FPP_t^g + \beta_2 \ln FERT_t + T + \mu_t$$

A crop that is a competitor with maize grain for land and inputs was indeterminate and thus not included. Table 5.6 illustrates that the main crop produced in South Africa are sugarcane, however, sugarcane and maize grain are not similar commodities and thus are not competitors for land or inputs. Intuitively yellow maize would be a major competitor for inputs and land. However, white and yellow maize future prices are highly correlated (96.1 percent) thus if it was included it would decrease the precision of the estimated parameters, increase the confidence intervals, and increase the standard errors in a small data set. Wheat was also hypothesized to be a major competitor for inputs with maize, however, wheat production was minor compared to maize production (Table 5.6). Ideally, all of these commodities would be included as competitors for inputs and land, but, due to the number of observations in the data set, this variable was omitted.

Table 5.6: Top 5 Maize Producing Provinces in South Africa, 2002

	Eastern Cape	Free State	North West	Mpumalanga	KwaZulu-Natal
			(1000 MT)		
Maize	1,460	5,227	5,057	1,311	402
White	536	1,918	1,856	481	148
Yellow	924	3,309	3,201	830	254
Wheat	2	1,540	34	0	15

Data Source: Lehohla (2002)

5.2.6.2 Data

The time series observed data for the analysis of supply for South Africa range from 1997 to 2006. As with the data used in the demand estimation for South Africa, all quantities have been converted to kilograms (kg) and prices have been deflated using the urban CPI deflator (Statistics of South Africa, 2008). Prices have also been converted to Meticals using the Interbank conversation rate (OANDA, 2008).

Quantity Supplied – Grain (QS^g)

In South Africa, only white maize production was desired since yellow maize is not used for human consumption in Mozambique. To achieve this, total production of maize was multiplied by the percent of white maize in total maize production (South African Department of Agriculture, 2008). Two percentages were used and applied to the time series data set. The first, 0.453 percent, was applied to 1997 through 1999, which was created based on production breakdowns of white and yellow maize provided during that time period (FAO, 1997). Using the 2005 percentage of production data, in addition, to a statement that white maize has surpassed yellow maize production, total maize production quantity for the remainder of the time series was multiplied by 0.633 to obtain total white maize production in South Africa (South African Department of Transport, 2005).

Futures Price of Maize Grain (FPP^g)

Future prices of maize grain were used as the expected price in the supply estimation equation for South Africa (South African Federal Exchange Board, 2008). Prices were based on contracts that started on November 15th with a delivery date of July for the following year.

Fertilizer (FERT)

A fertilizer price index for South Africa was used in place of yearly fertilizer prices, which were not available (South African Department of Agriculture, 2008).

Time Trend (T)

Economic time series have a tendency to change over time and this increase cannot always be accounted through measurable explanatory variables. Production of maize grain in South Africa has been increasing over the past years, therefore a time trend is included to capture all the effects causing a change in maize production in South Africa that is not due to prices of maize grain or fertilizer.

5.2.6.3 Results

Table 5.7 illustrates the econometric results for the estimation for the supply of maize grain in South Africa. The model has an R^2 of 17 percent and the overall model is not significant at a 10 percent level, according to the F-value. These results indicate that the model used to estimate supply of maize does not fully explain the variation in supply and does not have significant explanatory power for estimating supply of maize grain in South Africa.

Table 5.7: South African Supply Estimation

Dependent Variable = Production of Maize Grain, kgs			
Explanatory Variable	Coefficient	T-Stat (P-Value)	Significance
Future Price, Meticals/kg	0.13	0.46 (0.66)	
Fertilizer Price Index	0.38	0.44 (0.67)	
Time Trend	-0.01	-0.14 (0.89)	
Constant	20.80	7.49 (0.0)	***
F-Stat	0.58		
Prob >F	0.6457		
R-squared	0.1668		

Source: Estimated from secondary data sources
Note: Number of observations 11. All estimates in log-log form.
* Significance at the 10 percent level
** Significance at the 5 percent level
*** Significance at the 1 percent level

Multicollinearity between the explanatory variables was not found in this model of supply. However, the sample size is small in this estimation, like all others, causing the estimation results to be treated as if multicollinearity was in the model, including acknowledgment of high standard errors relative to the coefficients therefore causing coefficients to be highly susceptible to small changes within the sample.

As with all other estimation models in this study, the equation was tested for heteroscedasticity through the use of the Breusch-Pagan-Godfrey Test. The results failed to reject the null hypothesis and thus heteroscedasticity is likely present in the model. Autocorrelation was also tested for through the Durbin Watson test. The results accepted the null hypothesis and no autocorrelation was found in the model of supply of maize grain in South Africa. To correct for the heteroscedasticity, White's Robust Standard Error Estimation was used. This correction only adjusts the variances not the parameter estimates, with a large sample this would not be a concern as the loss of efficiency in the parameters would be minimal. However, with a small sample size, the efficiency loss in the parameters is greater.

Although not statistically different from zero, the coefficients do correspond with economic theory, including the price elasticity of supply, which indicates that the quantity supplied increases by 0.13 percent as the price of maize grain increase by 1 percent. However, that supply elasticity is low. Cruz (2006), in his analysis of storage in Mozambique, assumed a supply elasticity for maize grain in South Africa of 0.65. Based on the sensitivity test conducted (Appendix D), a supply elasticity of 0.13 will be used for South Africa.

5.3 Conclusion

This chapter presented the theoretical background for econometric methods used in the supply and demand estimation. In addition, the chapter has provided an in-depth discussion on the conceptual model chosen, the data used to estimate the models, and the results of the econometric estimations. The estimated supply and demand elasticities will be used to make the net social monetary welfare maximization model operational by using the estimated domestic elasticities to calculate the excess supply and demand elasticities. The use of the domestic elasticities is explained in the following chapter that begins with a detailed discussion of the conceptual social welfare model and data used.

6. SIMULATION

6.1 Operational Model

Chapter 4 outlined the theoretical basis for using a spatial equilibrium model to simulate welfare changes due to a change in tariff policy. The Durand-Morat and Wailes (2003) RICEFLOW model (equation 4.4) that simulates tariff policy changes in world rice trade was used as a template to create an empirical model (equation 6.6) that maximizes net social monetary welfare of Mozambique, by allowing all prices to adjust, subject to material balances and price constraints. The net social monetary welfare equation uses the intercepts and slopes of the excess supply and demand curves to maximize the social welfare as a sum of total social revenue for the consumption of imports in southern Mozambique less the sum of the total production exported in central Mozambique and South Africa less transport costs of the commodities from the exporting to the importing region. Thus, the problem is modeled as:

Maximize

(6.1)

$$\left(\alpha_s^f \cdot CIF_s^f - \frac{1}{2}\beta_s^f \cdot \left(CIF_s^f\right)^2\right) + \left(\alpha_s^g \cdot CIF_s^g - \frac{1}{2}\beta_s^g \cdot \left(CIF_s^g\right)^2\right)$$
$$-\left(\gamma_a^f \cdot FOB_a^f + \frac{1}{2}\delta_a^f \cdot \left(FOB_a^f\right)^2\right) - \left(\gamma_a^g \cdot FOB_a^g + \frac{1}{2}\delta_a^g \cdot \left(FOB_a^g\right)^2\right)$$
$$-\left(\gamma_c^f \cdot FOB_c^f + \frac{1}{2}\delta_c^f \cdot \left(FOB_c^f\right)^2\right) - \left(\gamma_c^g \cdot FOB_c^g + \frac{1}{2}\delta_c^g \cdot \left(FOB_c^g\right)^2\right)$$
$$-\left(TC_{as}^f \cdot FL_{as}^f\right) - \left(TC_{as}^g \cdot FL_{as}^g\right) - \left(TC_{cs}^f \cdot FL_{cs}^f\right) - \left(TC_{cs}^g \cdot FL_{cs}^g\right)$$

Subject to:

Price Restrictions:

(6.2) $CIF_s^f - FOB_a^f \leq TC_{as}^f + \left(ADVAL_{as}^f \cdot FOB_a^f\right)$

(6.3) $CIF_s^f - FOB_c^f \leq TC_{cs}^f$

(6.4) $CIF_s^g - FOB_a^g \leq TC_{as}^g + \left(ADVAL_{as}^g \cdot FOB_a^g\right) + (VAT_{as}^g \cdot OPP_c^{vat} \cdot MN_c^{vat} \cdot FOB_a^g)$

(6.5) $CIF_s^g - FOB_c^g \leq TC_{cs}^g$

Material Balances:

(6.6) $FL_{as}^{f} + FL_{cs}^{f} + FL_{ws}^{f} = \alpha_{s}^{f} + \beta_{s}^{f} \cdot CIF_{s}^{f}$

(6.7) $FL_{as}^{g} + FL_{cs}^{g} + FL_{ws}^{g} = \alpha_{s}^{g} + \beta_{s}^{g} \cdot CIF_{s}^{g}$

(6.8) $FL_{as}^{f} \leq \gamma_{a}^{f} + \delta_{a}^{f} \cdot FOB_{a}^{f}$

(6.9) $FL_{as}^{g} \leq \gamma_{a}^{g} + \delta_{a}^{g} \cdot FOB_{a}^{g}$

(6.10) $FL_{cs}^{f} = \gamma_{c}^{f} + \delta_{c}^{f} \cdot FOB_{c}^{f}$

(6.11) $FL_{cs}^{g} = \gamma_{c}^{g} + \delta_{c}^{g} \cdot FOB_{c}^{g}$

(6.12) $CIF, FOB, FL \geq 0$

Table 6.1: Variables, Parameters and Subscripts Description for Welfare Model

Variable/Parameter	**Description**		
α	Excess demand intercept	*PROD*	Quantity of domestic production
β	Excess demand slope	*X*	Export quantity
γ	Excess supply intercept	E_S	Domestic elasticity of supply
δ	Excess supply slope	E_d	Domestic elasticity of demand
FOB	Price in the exporting country	E_{esj}	Excess supply elasticity
TC	Transport cost	E_{sdi}	Excess demand elasticity
FL	Quantity of the commodity flowing from one region to another	*EC*	Extraction cost
ADVAL	Ad-Valorem Import Tariff	*CON*	Quantity of domestic consumption
VAT	Value Added Tax	*M*	Import quantity
CIF	Price in the importing country	*OPP*	Opportunity Cost
MN	Months		

Subscript	**Description**		
f	Flour	*a*	South Africa
g	Grain	*s*	Southern Mozambique
y	Commodity type	*c*	Central Mozambique
vat	VAT	*w*	World (excluding South Africa)
i	Importing country	*j*	Exporting country/region

Note: See Appendix C for a more detailed table, including values used.

The price constraints (equations 6.2 through 6.5) maintain price conditions. Thus, if the difference between the prices for a given commodity between the exporting and importing country exceeds the cost of transport and when applicable tariff rates (with allowance for normal profits), then new competitors will enter the industry until retail prices decline and the constraint is again satisfied. The material balance equations require that the quantities flowing between the importing and exporting regions are equal to the quantities being demanded from the importing region and quantities supplied from the exporting region. Specifically, the first two material balance constraints (equations 6.6 and 6.7) require that the amount demanded in the importing country, which is dependent on the excess demand slope and intercept, in addition to the importing price of the given commodity, is equal to the amount of imports at the same given point in time. The next four material balance constraints (equations 6.5 thru 6.11) require that the quantity exported from a given region is equal to that region's available excess supply given the excess supply slope and intercept and the export price of the given commodity. The final material balance constraint (equation 6.12) requires that prices and quantities exported and imported be greater than or equal to zero.

This model makes a few important assumptions that should be noted. The first assumption is that the supply and demand elasticities for the raw and processed commodity are equal. In other words, the supply elasticity of maize flour for central Mozambique will be equal to the supply elasticity estimated in Chapter 5 for maize grain in central Mozambique. Therefore the supply curve for maize flour is derived through the adjustment of extraction rates and will be a parallel shift towards the origin. The same is true for demand, as the elasticity of demand for maize grain for each region is derived from the estimated elasticity of demand for maize flour. The second assumption is that seasonality variation in the movement of maize grain and maize flour from South

Africa and central Mozambique does not exist. This is assumed since the maize grain imported from South Africa to southern Mozambique is purchased by the large maize millers and the majority of maize grain used to process maize flour in southern Mozambique is imported from South Africa. In other words, the maize grain from South Africa is not sensitive to production in Mozambique, which resorts into a situation where seasonality variation of maize grain imported is not a factor.

The remaining assumptions pertain to the VAT. First, the VAT on domestic trade of maize grain and flour between central and southern Mozambique is assumed to be zero due to lack of enforcement and monitoring of grain flowing from center to south. In other words, transport is the only additional cost on grain or flour moving from the center to southern Mozambique. The second assumption is that as stated in the VAT policy, the VAT is reimbursed to the buyer of the imported maize grain within three months as long as the maize grain has been purchased for the sole intention to be processed into maize flour (Tschirley and Abdula 2007). Therefore, the model assumes the actual VAT added to the price of maize grain entering from South Africa is an opportunity cost of money lost during the reimbursement period (3 months).

6.1.1 Excess Supply and Demand

This maximization equation is modeled using the excess supply and demand intercepts and slopes, which must be derived from the domestic supply and demand elasticities that were estimated in Chapter 5. Koo and Kennedy (2005) and Durand-Morat and Wailes (2003) outline the general linear excess supply and demand elasticity equations used in this study. As originally shown as equation 4.8, equation 6.13

illustrates the linear excess supply elasticity equations used for South Africa and central Mozambique. Equation 6.14, which was shown as equation 4.9 in Chapter 4, was used to calculate the excess demand elasticity for southern Mozambique.

(6.13) $$E_{esj} = E_{sj}\left(\frac{PROD_j^g}{X_j^g}\right) - E_{dj}\left(\frac{\frac{1}{EC_j} \cdot CON_j^f}{X_j^g}\right)$$

(6.14) $$E_{eds} = E_{ds}\left(\frac{\frac{1}{EC_s} \cdot CON_s^f}{M_s^g + FL_{cs}^g}\right) - E_{ss}\left(\frac{PROD_s^g}{M_s^g + FL_{cs}^g}\right)$$

Note: See Table 6.1 for variable descriptions.

The same assumption of equal elasticities for supply of maize flour and supply of maize grain is applied to the use of excess supply and demand. In this case, excess supply and demand elasticities were calculated for maize grain and assumed to be equal to excess supply and demand elasticities of maize flour.

6.1.2 Excess Supply and Demand Slopes and Intercepts

The excess supply and demand elasticities are then used to calculate the intercept and slope of the respective excess supply and demand function in quantity dependent form for each region and commodity. The quantity dependent supply function (equation 6.15) was manipulated to create the slope (equation 6.16) and the intercept (equation 6.17). The equations are used for both maize grain and flour in both central Mozambique and South Africa. The linear excess demand function for southern Mozambique (equation 4.20) was used in the same manner as the excess supply function to calculate the slope (equation 6.19) and intercepts (equation 6.20) for the excess demand function.

(6.15) $X_j^y = \gamma_j^y + \delta_j^y FOB_j^y$

(6.16) $\delta_j^y = \frac{X_j^y}{FOB_j^y} \cdot E_{esj}$

(6.17) $\gamma_j^y = X_j^y - \delta_j^y \cdot FOB_j^y$

(6.18) $M_s^y = \alpha_s^y + \beta_s^y CIF_s^y$

(6.19) $\beta_s^y = \frac{M_s^y + FL_{cs}^y}{CIF_s^y} \cdot E_{sds}$

(6.20) $\alpha_s^y = (M_s^y + FL_s^y) - \beta_s^y \cdot CIF_s^y$

Note: See Table 6.1 for variable descriptions.

6.1.3 Data

The net social monetary welfare maximization is done for a static time period. This analysis uses the 2006/2007 Mozambique marketing year, which runs from April 2006 to March of 2007. This marketing year was chosen for two reasons. First, it is the most recent year in which complete data were available for Mozambique. Second, and more importantly, the 2006/2007 marketing year is very representative of a typical production year both in quantity produced and producer price (Table 6.2).

For this model, quantities have been converted to metric tons (mt). In addition, all prices have been deflated to 2004 and converted to the new Mozambique Metical. Donovan (2008) created a non-food, urban CPI deflator that was used in replace of an all items CPI deflator for Mozambique. A non-food item CPI deflator was used due to the high expenditure spent on food in Mozambique and the invalid weighting that can occur when deflating an item that has a high expenditure percentage in that CPI. Due to the lower percent of income spent on food in South Africa, South African prices were deflated using the urban all items CPI deflator (Statistics South Africa, 2008). When data were reported in U.S. dollars, the all items, urban CPI deflator for U.S. dollars was used (United States Department of Labor Statistics, 2008). For both the South Africa Rand and the United States Dollar, the exchange rate to Meticals was obtained on OANDA (2008), a foreign currency website which provides historic exchange rates at the Interbank rate.

Table 6.2: Historic Maize Prices and Production for Southern/Central Mozambique

	Maize Flour Retail Price (Met/mt)		Production ('000 mt)		Maize Grain Producer Price (Met/mt)
	Maputo (South)	Beira (Center)	South	Center	Chimoio (Center)
2002	10832	8972	118	491	2386
2003	11842	9208	137	571	2132
2004	11910	11056	151	629	2343
2005	12195	13134	211	878	2911
2006	12086	13879	151	628	2343
Average for 2002 to 2006	11772.87	11249.64	153.6	639.4	2423.07
% difference of average and 2006	2.7%	23%	1.7%	1.8%	3%

Data Source: SIMA (2008) and FEWSNET (2008)

Consumption of Flour (CON)

Consumption of flour was needed to calculate the excess supply and demand elasticities of the regions. Official data for consumption of maize flour were not available. However, just as the quantity of flour demanded was calculated for the South

African demand estimation in Chapter 5, consumption for 2006/2007 was calculated the same manner. The food balance equation (equation 6.21) was used where the sum of production, imports, and beginning storage equals the sum of consumption, exports, and ending storage. Through the use of the food balance equation, the disappearance method was used to calculate the total quantity of maize flour consumed in South Africa.

(6.21) $$PROD + IMPORTS + STOR_s = CONSUMP + EXPORTS + STOR_e$$

Data on consumption of maize flour in both regions of Mozambique were not available. Therefore it was calculated in the same manner as the quantity demanded of flour parameter for both central and southern Mozambique in Chapter 5. That is, consumption of maize flour was calculated based on 1996 expenditure (IAF, 1996), per capita expenditure GDP (INE, 2008), maize flour prices (SIMA, 2008) and total population of the regions (INE, 1997).

Before an average weighted expenditure can be calculated, a weighted population must be calculated using INE population provincial estimates and 1997 provincial urban and rural breakdowns from a national census. Using the weighted population estimates, an average weighted expenditure for 2006 for both the southern and central regions of Mozambique was calculated using 1996 expenditure data (equation 6.22). Expenditure spent on maize and maize derivatives for 1996 was determined to be the best alternative for the 2006 consumption calculation based on the normalized prices of maize flour and rice, which are approximately the same in 1996 and 2006 (Figure 1.1). After a weighted expenditure for maize flour for the central and southern regions of Mozambique was calculated, expenditure GDP per capita, the retail price of maize flour and total population were used to estimate the total consumption of maize flour for each region (equation 6.23).

(6.22)

$$EXP_r^w = \sum \left\langle \left[\left(PPOP_p^{urban} \cdot 96EXP_p^{urban} \right) + \left(PPOP_p^{rural} \cdot 96EXP_p^{rural} \right) \right] \cdot \frac{POP_p}{POP_r} \right\rangle$$

(6.23)

$$CON_r^f = \left(\frac{GDP_r^{pc} \cdot EXP_r^w}{CP_r^f} \right) \cdot POP_r$$

Table 6.3: Parameter Description for Maize Flour Consumption Calculation

Variable/Parameter	**Description**		
EXP	Expenditure	*POP*	Population
96EXP	Percent Expenditure from 1996	*PPOP*	Percent Population
GDP	Gross Domestic Product	*CP*	Retail Price
CON	Consumption		
Subscript	**Description**		
w	Weighted	*r*	Region
p	Province	*f*	Flour
urban	Urban	*rural*	Rural
pc	Per capita		

Note: See Appendix C for a more detailed table, including values used.

The problems with the construction of this variable must be acknowledged. Specifically, the percent of urban and rural inhabitants from 1997 used to create a 2006 rural/urban breakdown. The 1997 percentages are most likely not consistent with the percentage of population in rural and urban areas in 2006. In addition, using an expenditure that includes maize and maize derivatives, almost undoubtedly skews the consumption of maize flour upwards. However, both the urban and rural breakdown and the expenditure percentage of maize and maize derivatives were the only available data.

Production of Grain (PROD)

Data were found on total production of maize for the South African marketing season[16] (South African Department of Agriculture, 2008). Total production of maize was multiplied by the percentage of white maize in total production. Using the 2005 percentage of production data, in addition, to a statement that white maize has surpassed yellow maize production, total maize production quantity for 2006/2007 was multiplied by 0.633 to obtain total white maize production in South Africa (South African Department of Transport, 2005). Data on total white maize grain production by region in Mozambique for the 2006/2007 production season were found (FEWSNET, 2007).

Export Price (FOB)

The Free On Board (FOB) price was used for the exporting regions' prices for both commodities in the calculation of the slopes and intercepts of the excess supply curves. In both central Mozambique and South Africa, the FOB maize grain price is equal to the domestic producer price. The 2006 producer price of maize grain for Chimoio, the largest producing region in central Mozambique, was calculated as an average of reported producer prices throughout Chimoio during May to October, which is the period when producers sell maize grain (SIMA, 2008). Data on producer prices in

[16] The South Africa maize marketing season is from May to April of the following year.

South Africa were found and reported as aggregate yearly maize marketing season price (South African Department of Agriculture, 2008). FOB maize flour price data were calculated as the total FOB value of maize flour exports for 2006 divided by the total quantity of maize flour exported in 2006 (SARS, 2008). For central Mozambique, daily reported warehouse prices of maize flour were aggregated to create a 2006/2007 FOB price of maize flour (SIMA, 2008).

Import Price (CIF)

The Cost, Insurance and Freight (CIF) price was used as the price measurement for both commodities in the importing country. Unfortunately, a CIF price could not be found for southern Mozambique and thus was calculated. Since the CIF price equals the price of the product in the exporting country, plus transport and insurance costs, the CIF price for maize flour in southern Mozambique was calculated as South Africa's FOB maize flour price plus transport costs, plus the FOB price in South Africa times the ad-valorem import tariff that is applied to all imports of maize flour from South Africa to southern Mozambique.

The price for maize grain in southern Mozambique was calculated in the same manner, except the FOB price of maize grain was used and the VAT tax was multiplied times the South African FOB maize grain price and added into the CIF maize grain price.

Since the majority of maize grain entering Mozambique is used to produce maize flour which allows for the VAT to reimbursed, there is little reason to apply the whole VAT to the FOB price of maize grain from South Africa. Therefore to capture the opportunity lost to the millers due to lack of access to the money used to pay the VAT, an interest rate of 2 percent per month (Ardnt *et al*, 2001) was multiplied by the VAT times the reimbursement period. The reimbursement of the VAT is suppose to occur within 3 months of payment, however survey results from Tschirley and Abdula (2007) report longer reimbursement time periods. However, 3 months was used as the reimbursement period since it is the government advertised return rate and data are not available on the actual reimbursement time period.

Extraction Rate (ER)

Ndibongo-Traub (2004) noted that for the highest quality of maize flour the extraction rate of a South African industrial miller was 62 percent. Abdul (2005) surveyed Mozambique industrial millers and found that the main industrial miller in the center, V&M, had an extraction rate of 80 percent for its highest quality maize flour. In the south, CIM, the industrial miller with the largest market share had an extraction rate of 65 percent for its highest quality maize flour, Top Score.

Flow Rate (FL)

The export (flow) quantity data of maize grain, except seed, from South Africa to Mozambique were available (United Nations, 2008). However, quantity traded was reported in the calendar year for 2006, not the marketing year of Mozambique. In addition, there was no distinction made between white and yellow maize. However, it was assumed that all maize grain entering Mozambique was white maize since yellow maize is rarely consumed in Mozambique. Data on maize flour exports to Mozambique from South Africa were available for the 2006 calendar year (United Nations, 2008).

Flow of grain from the center to southern Mozambique was more difficult to quantify. Abdula (2008) contended that it would be very difficult to get accurate numbers on the flow of maize due to the large share of the market served by informal traders. Cargo trucks returning to Maputo often transport agriculture commodities for informal traders, including maize grain, to the city as a form of reducing their return trip transport cost. Tracking of this type of maize grain flow, often called backhaul, has not yet been done. SIMA provided estimated flow data on maize grain; however the data were only for certain markets and not a general representation of maize grain flow. Abdula (2008) maintained that the flow numbers from SIMA would represent 40 to 70 percent of total grain movement.

Due to the difficulty in measuring grain flow from central to southern Mozambique, the disappearance method was used to determine grain quantity originating from the center of the country (equation 6.24). The quantity of maize grain was calculated by summing total quantity of maize grain consumed in southern Mozambique, less the sum of the production of grain in the south, flow of grain from South Africa, and the flow of grain from the rest of the world.

(6.24) $$FL_{cs}^{g} = CON_{s}^{g} - (PROD_{s}^{g} + FL_{as}^{g} + FL_{ws}^{g})$$

There are two important assumptions about the flow of maize grain should be noted. The first is that all maize grain imports into Mozambique are intended for the southern region. This assumption is reasonable considering that the southern region is the only part of Mozambique that does not produce enough maize grain to support its own demand and is typically in need of additional maize grain from outside sources. In addition, this study assumes that all imported maize grain is white maize due to the preference of the population for white maize over yellow maize for human consumption and the lack of commercial livestock sector demand for yellow maize for livestock feed.

Little to no data are available on the movement of maize flour from the center to the south. However, Abdula (2008) notes that at maximum, 5 percent of the maize flour traded in the south may have originated from the center. In addition, as briefly mentioned about by Abdula and Tschirley (2007) the market share of maize meal is highly concentrated by two main milling industries in the south and when stock was taken of both in the main open air markets in Maputo and major retail chains, no brands of maize flour from the center were recorded, making any flow from center to south most likely informal. Flow of maize flour from the center to the southern region of Mozambique will be assumed[17] 1mt in this study.

Transportation Cost (TC)

Transport cost for both maize grain and maize flour between central and southern Mozambique was calculated based on the distance between Chimoio, the main production point in central Mozambique, and Maputo City, the main consumption zone in the south. The SIMA data on transport costs were reported in a per bag price, which was then converted into a per ton cost (SIMA, 2008). To check for validity in the transport estimate, the cost was then compared to transportation cost estimates in Cruz (2006), which were similar. The SIMA transportation cost was used for both transportation of maize grain and maize flour since it is a per ton cost.

[17] Ideally, the quantity would be assumed to be zero, however, due to the nature of the calculations being made, the flow from central to southern Mozambique must be greater than zero.

For South Africa, the transportation cost was calculated by using the cost per ton per kilometer found in Cruz (2006). Since 2006 is the desired year for analysis, the cost was converted to 04 Meticals and then multiplied by the distance from the major source of maize grain in South Africa, Nelspruit, to Maputo City. Again, this cost is used for transport of both maize grain and maize flour as it is a cost per metric ton.

6.2 Simulation

Excess supply elasticities for central Mozambique and South Africa and an excess demand elasticity were calculated using the respective domestic supply and demand elasticities (equations 6.13 and 6.14). Central Mozambique had an excess supply elasticity of 0.79, South Africa had an excess supply elasticity of 4.15 and southern Mozambique had an excess demand elasticity of -0.73. Other empirical estimates of supply elasticities of maize remain around 1 to 2, which is consistent with the excess supply elasticity for central Mozambique, but suggests the excess supply elasticity of South Africa is high. In the RICEFLOW model, the highest excess supply elasticity used was around 3.0 in China and India for supply of long grain low quality rice. Durand-Morat and Wailes (2003) also noted that when excess elasticities seemed unreasonably high, the elasticities were adjusted to a more reasonable level. Exports of maize grain and maize flour from South Africa to Mozambique are only a minor percentage of South African exports, while they are a large fraction of Mozambique's total world imports of maize grain and maize flour (Table 2.6 and 2.7). Therefore, it does not seem to be unreasonable for the excess supply curve of South Africa to be responsive to a price change and thus have such an elastic excess supply curve. The excess demand curve elasticity is compatible with the range of excess demand elasticities used in Durand-Morat and Wailes (2003) for similar countries and quality grades of rice. The excess elasticities of supply and demand were then used to calculate the slopes and intercepts for both maize grain and maize flour for each excess supply and demand curve (equations 6.15 to 6.20). The elasticities, intercepts and slopes were held constant in the simulations to measure the changes occurring due to a change in the policy. A complete list of values used can be found in Table C.1 (Appendix C).

6.2.1 Model Validity

Before the VAT and import tariffs removal simulations were performed, the validity of the model is tested in two ways. First, by comparing the simulated baseline results found though the use of the estimated elasticities compared to the observed values to verify that the model correctly simulates accurate values. Second, through sensitivity tests that were conducted by making small changes in the estimated domestic demand and supply elasticities used to verify the robustness of the model to small changes.

6.2.1.1 Baseline

A baseline was first run to determine the validity of the model. Table 6.4 shows the observed data, simulated results and the percent difference between the simulated and observed data points. The model successfully estimates a majority of the variables within 10 percent of the observed value. No estimated value is more than 35 percent different from the observed value. The highest difference variable is the flour price in central

Mozambique. It is believed that the price used as the observed value is higher than the actual FOB flour price in central Mozambique, however it was the best data available.

Table 6.4: Baseline Results

Variables	Observed (04 Met/MT)	Simulated (04 Met/MT)	Percent Difference
Southern Mozambique Prices			
Grain	3,140.12	2,896.17	-7.77
Flour	7,391.05	7,170.03	-3.0
Central Mozambique Prices			
Grain	2,342.56	1,846.17	-21.19
Flour	9,301.93	6,120.03	-34.21
South Africa Prices			
Grain	3,034.66	2,771.6	-8.67
Flour	6,136.7	5,952.52	-3.0
	(MT)		
Exports from South Africa to Southern Mozambique			
Grain	85,256	56,539.1	-33.68
Flour	2,628	2,686.02	2.21
'Exports' from Central to Southern Mozambique			
Grain	257,743	214,059	-16.95
Flour	1	0.726399	-27.36
Consumption of Maize Flour			
Southern Mozambique	196,045.77	194,944.7	-0.56

Source: Estimated by the Author

6.2.2.2 Sensitivity Tests

Sensitivity tests were then conducted to test not only the validity of the model, but also the sensitivity of the model to small changes in the domestic demand and supply elasticities used. In addition, the quantity of maize flour traded between central

Mozambique and southern Mozambique was also tested for sensitivity since the observed value was assumed.

Table 6.5 shows the simulated results and percent difference from the observed values for the 'best'[18] sensitivity test results and the ARMA estimated elasticities, which were used to correct for the unit roots[19]. In general, a change in one elasticity typically led to one variable being more accurately simulated, while another variables simulated value became less accurate (the percent difference between the simulated and observed value increased in absolute terms). Most variables appeared to be resilient to small changes in elasticities used, which was seen through little variation between the percent differences between the observed and simulated results across all sensitivity tests.

South African maize grain quantity was the only variable that seemed to fluctuate more due to a change in elasticity. The reason for the fluctuation is unknown, especially considering the observed value of exports of maize grain from South Africa to Mozambique was cross checked and came from a reliable source. In addition, the simulated central Mozambique maize flour price is considerably different from the observed price in all tests, however, the simulated prices remain consistent. It is hypothesized that this difference occurs due to the lack of accuracy in the observed FOB price of central Mozambique maize flour price, not to the accuracy of the model. Even with these differences, between all sensitivity test runs, there is very little discrepancy between the observed and simulated values, indicating the models overall accuracy in simulating the trading environment between South Africa and Mozambique. In addition,

[18] The "best" elasticities were determined by comparing the difference between the observed values and the simulated values over all sensitivity tests ran. See Appendix D to see a complete table of all sensitivity tests ran and a more detailed discussion on the sensitivity test results.
[19] See Appendix B for the discussion on unit roots and the estimated elasticities from the ARIMA models.

the consistency of the simulated values under different elasticities indicates the models overall resilience to small changes in the elasticities used.

There was some variation in the quantity of maize flour from central Mozambique as well. Since the quantity of maize flour for central Mozambique was an assumed value and there was considerable variation in the percent difference between the different simulated and observed values in the elasticity sensitivity tests, sensitivity tests were conducted to determine if the low assumed value of the variable was the cause of the high variation occurring between the simulated and assumed values (Table 6.6). The results indicated that the assumed value of the maize flour had little to do with the percent difference the simulated and observed values. In other words, the percent difference between the assumed and simulated values did not vary when the assumed quantity of maize flour changed. This indicated the models inability to accurately simulate the value of maize flour traded between central Mozambique and southern Mozambique.

Therefore, based on the small differences between the simulated baseline values, using the OLS estimated elasticities, and the observed values, in addition to the sensitivity test results that indicate the models overall robustness to small changes, the model is an overall accurate representation of the maize trade environment between southern Mozambique, central Mozambique and South Africa. Therefore, it can be assumed the simulated results of the VAT and import tariff removal are representative of actual results that would have occurred if the VAT and import tariffs would have been removed during the 2006/2007 Mozambique marketing season.

Table 6.5: Sensitivity Test - Change in Domestic Elasticities

Variables	Baseline - Author Est.			Sensitivity Run 19			Sensitivity Run 24		
				S: D.1(4)		***D: D.2(13)***	***ARIMA Estimates***		
	SM	CM	SA	SM	CM	SA	SM	CM	SA
Domestic Supply	0	0.17	0.13	0.25	0.42	0.38	0	0.22	0.78
Domestic Demand	-0.89	-0.33	-0.50	-1.14	-0.58	-0.75	-1.02	-0.48	-0.55
	Value		Percent	Value		Percent	Value		Percent
				Prices (Met/MT)					
Southern Moz.									
Grain	2,896		*-7.77*	3,076		*-2.04*	3,064		*-2.4*
Flour	7,170		*-2.99*	7,472		*1.10*	7,358		*0.0*
Central Moz.									
Grain	1,846		*-21.19*	2,026		*-13.51*	2,014		*-14.03*
Flour	6,120		*-34.21*	6,422		*-30.96*	6,308		*-32.19*
South Africa									
Grain	2,772		*-8.67*	2,945		*-2.94*	2,934		*-3.30*
Flour	5,953		*-3.00*	6,204		*1.10*	6,109		*0.0*
				'Export' Quantity (MT)					
Central Moz.									
Grain	214,059		*-16.95*	199,185		*-22.72*	217,917		*-15.45*
Flour	0.73		*-27.36*	0.48		*-52.05*	0.645		*-35.50*
South Africa									
Grain	56,539		*-33.68*	61,325		*-28.07*	42,549		*-50.0*
Flour	2,686		*2.21*	2,599		*-1.09*	2,638		*-0.0*
				Consumption (MT)					
Southern Moz.									
Flour	194,945		*-0.56*	188,301		*-4.11*	188,311		*-3.40*

Source: Estimated by Author

Table 6.6: Sensitivity Analysis - Quantity of Central Mozambique Maize Flour

Variables	Observed Values	Baseline - Author Est. FLFAS=1		Sensitivity Run 25 FLFCS=50		Sensitivity Run 28 FLFCS=500	
		Value	Percent	Value	Percent	Value	Percent
		Prices (Met/MT)					
Southern Moz.							
Grain	3,140	2,896	*-7.77*	2,896	*-7.77*	2,896	*-7.77*
Flour	7,391	7,170	*-2.99*	7,160	*-3.13*	7,067	*-4.39*
Central Moz.							
Grain	2,343	1,846	*-21.19*	1,846	*-21.19*	1,846	*-21.19*
Flour	9,302	6,120	*-34.21*	6,110	*-34.32*	6,017	*-35.32*
South Africa							
Grain	3,035	2,772	*-8.67*	2,772	*-8.67*	2,772	*-8.67*
Flour	6,137	5,953	*-3.00*	5,944	*-3.14*	5,866	*-4.40*
		'Export' Quantity (MT)					
Central Moz.							
Grain	257,743	214,059	*-16.95*	214,059	*-16.95*	214,059	*-16.95*
Flour		0.73	*-27.36*	36	*-27.45*	360	*-28.05*
South Africa							
Grain	85,256	56,539	*-33.68*	56,539	*-33.68*	56,539	*-33.68*
Flour	2,628	2,686	*2.21*	2,653	*0.96*	2,355	*-10.39*
		Consumption (MT)					
Southern Moz							
Flour	196,046	194,945	*-0.56*	194,947	*0.00*	194,972	*0.01*

Source: Estimated by Author

6.2.2 Remove of the Value Added Tax (VAT)

The first scenario conducted was the removal of the VAT (Table 6.7). In the model, the VAT was applied to import maize grain from South Africa as an opportunity cost to the millers that occurs due to the structure of the VAT that causes the millers to pay the VAT and then wait 3 months for the VAT to be refunded by the government. Specifically, the opportunity cost was calculated as the South African FOB price of maize grain (3,140.12), the VAT (17 percent), interest rate in urban Mozambique (2 percent), and the government reported refund time period (3 months). The southern Mozambique CIF price thus became (excluding the 2.5 percent import tariff on grain) 3,172.15 Meticals/mt, which is only a 1 percent difference between the South African FOB price and southern Mozambique CIF price.

Since the VAT is only applied to the maize grain and results in a relatively small increase in CIF price, it is not surprising that there is no change in prices and quantities traded of maize flour in any region. The removal of the VAT causes all maize grain prices to decrease, however the change in price is small, with the largest percent decrease in central Mozambique (-1.74 percent) FOB price. The most significant result is the increase of exported grain from South Africa to southern Mozambique, which is an increase by almost 9 percent with the removal of the VAT. A corresponding decrease in flow of maize grain from the center to the south occurs, but to a lesser degree (-1.32 percent). Although these changes in prices and quantities traded appear small, bear in mind that the original price difference was only 1 percent between the South African FOB price and the southern Mozambique CIF price.

Table 6.7: VAT Removal Results

Variables	Simulated Baseline (04 Met/MT)	VAT Removal Simulation (04 Met/MT)	Percent Difference
Southern Mozambique Prices			
Grain	2,896.17	2,864.10	-1.12
Flour	7,170.03	7,170.03	0
Central Mozambique Prices			
Grain	1,846.17	1,814.1	-1.74
Flour	6,120.03	6,120.03	0
South Africa Prices			
Grain	2,771.6	2,767.88	-0.13
Flour	5,952.52	5,952.52	0
	(MT)		
Exports from South Africa to Southern Mozambique			
Grain	56,539.1	61,465.4	8.71
Flour	2,686.02	2,686.08	0
'Exports' from Central to Southern Mozambique			
Grain	214,059	211,236	-1.32
Flour	0.726399	0.726399	0
Consumption of Maize Flour			
Southern Mozambique	194,944.7	196,089.6	0.59

Source: Estimated by Author

The removal of VAT would have a positive affect on consumers in southern Mozambique with higher consumption and lower prices, while producers in central Mozambique will be negatively affected due to lower demand for their grain and lower export prices. However, in this first scenario the largest gainer is the maize grain producers in South Africa, with an increase demand for their commodity and a very small increase in export price.

6.2.3 Remove Import Tariff Escalation

The second scenario simulated is the removal of the import tariffs on both maize grain and maize flour to eliminate the import tariff escalation. More specifically, the import tariff of 2.5 percent on maize grain and 20 percent on maize flour applied to imports from South Africa are removed, however the VAT applied to imports of maize grain remains (Table 6.8).

Table 6.8: Import Tariff Escalation Removal Results

Variables	Simulated Baseline (04 Met/MT)	Tariff Removal Simulation (04 Met/MT)	Percent Difference
Southern Mozambique Prices			
Grain	2,896.17	2,817.65	-2.71
Flour	7,170.03	5,699.72	-20.51
Central Mozambique Prices			
Grain	1,846.17	1,767.65	-4.25
Flour	6,120.03	4,649.72	-24.03
South Africa Prices			
Grain	2,771.6	2,762.46	-0.33
Flour	5,952.52	5,672.7	-4.70
	(MT)		
Exports from South Africa to Southern Mozambique			
Grain	56,539.1	68,598	21.33
Flour	2,686.02	3,070.63	14.32
‘Exports’ from Central to Southern Mozambique			
Grain	214,059	207,149	-3.23
Flour	0.726399	0.599971	-17.41
Consumption of Maize Flour			
Southern Mozambique	194,944.7	198,391.4	1.77

Source: Estimated by Author

The removal of the escalating import tariffs has a greater affect on prices, consumption and quantities traded than the results found when only the VAT was removed. All prices in both the importing and exporting regions see a decline, with the greatest decrease occurring in price of maize flour in both southern and central Mozambique. The large decrease in the maize flour price in central Mozambique could represent an inflated maize flour price in the center that now must decline to be competitive when the tariffs are removed. Although the increase in consumption is small (1.77 percent), quantities of maize grain and maize flour exported from South Africa to Mozambique saw a considerable increase with the removal of the import tariffs. Specifically, the removal of the tariff allowed for exports from South Africa to increase by 21 percent for maize grain and 14 percent for maize flour.

The results of this scenario indicate that consumers in southern Mozambique and millers and producers in South Africa will have the most to gain. Consumers in southern Mozambique will see a considerable decrease (20.51 percent) in maize flour prices and a slight decrease (2.71 percent) in maize grain prices. Quantity available of grain will increase as exports from South Africa increase more than decreased flow quantities approximately from central Mozambique by approximately 18 percent. Producers of maize grain and millers of maize flour in South Africa will also gain considerably from this change in import policy as FOB prices of both commodities decrease slightly (maximum of 5 percent) but the export quantities of both commodities increase significantly (minimum of 14 percent). Millers of maize flour and producers of maize grain in central Mozambique will be negatively affected by this change in tariff policy due to decrease in quantities flowing from the center to south of both commodities and the decrease in FOB prices of both commodities.

6.2.4 Free Trade

The final scenario is the removal of all trade restricting policies related to maize grain and maize flour (Table 6.9). The scenario results show the largest changes. More specifically, by removing both the VAT and import tariff from the FOB price of imported grain from South Africa, both the FOB price in central Mozambique and CIF price in southern Mozambique decrease more than either individual removal. Very little change occurs in the FOB price of maize grain in South Africa (-0.47 percent), with a slightly greater decrease in South African maize flour prices (4.70 percent), but still nowhere near the percent change found in either region of Mozambique. Consumption increases (2.5 percent) the greatest under this scenario.

As with the removal of the import tariffs, consumers in southern Mozambique and producers and millers in South Africa are going to be better off under the free trade scenario when compared to the status quo. Consumers have the highest consumption of maize flour under this scenario with the lowest price of maize flour, allowing them to consume more for less. Producers of maize grain in South Africa have the highest increase in demand for maize grain (increase of 30 percent of the baseline) under the free trade scenario, with little change in the FOB price (-0.47 percent). Millers in South Africa see the exact same results that occur under the tariff removal scenario, since maize flour is not affected by the VAT, however, the South African millers are still better off with greater increase in quantity demand for their commodity (14.32) over a decrease in the FOB price (-4.7 percent).

Table 6.9: Free Trade (Removal of VAT and Import Tariffs) Results

Variables	Simulated Baseline (04 Met/MT)	Free Trade Simulation (04 Met/MT)	Percent Difference
Southern Mozambique Prices			
Grain	2,896.17	2,785.71	-3.81
Flour	7,170.03	5,699.72	-20.51
Central Mozambique Prices			
Grain	1,846.17	1,735.71	-5.98
Flour	6,120.03	4,649.72	-24.03
South Africa Prices			
Grain	2,771.6	2,758.7	-0.47
Flour	5,952.52	5,672.7	-4.70
	(MT)		
Exports from South Africa to Southern Mozambique			
Grain	56,539.1	73,503	30.0
Flour	2,686.02	3,070.63	14.32
'Exports' from Central to Southern Mozambique			
Grain	214,059	204,338	-4.54
Flour	0.726399	0.599971	-17.41
Consumption of Maize Flour			
Southern Mozambique	194,944.7	199,716.6	2.45

Source: Estimated by Author

Producers of maize grain and millers of maize flour in central Mozambique are again the only groups negatively affected by this change in policy to a free trade scenario. Maize grain producers in the center are negatively affected less than millers, as producers only see a slight decrease in FOB price (-5.98) and slight decrease in quantity traded (-4.54 percent). Millers, on the other hand, see considerable decreases in both prices (-24.03 percent) and quantities traded (-17.41).

6.3 Conclusion

This chapter provides a discussion of the empirical model and data used to empirically measure the changes that occur as a result of the removal of restricting trade policies. The chapter then provided the results to three different scenarios: (1) removal of the VAT on South African maize grain, (2) removal of the import tariffs on South African maize grain and maize flour, and (3) free trade (removal of both the VAT and import tariffs). The results indicated that little change occurred under the removal of the VAT along but both the removal of the tariffs and a free trade scenario resulted in consumers in southern Mozambique and producers and millers in South Africa being better off compared to the status quo, while producers and millers in central Mozambique were worse off.

7. CONCLUSION

7.1 Summary

Import tariff escalation occurs when a country applies a greater import tariff on processed goods than the raw commodity counterpart. Typically researched as a north-south trade barrier, which blocks developing countries ability to export processed products, thus requiring developing countries to focus on raw material exports, little research on the implications of import tariff escalation as a south-south trade barrier exists, even though many developing countries also use import tariff escalation.

Mozambique is an example of a developing country using import tariff escalation as a means of protecting its maize production and processing industry. Mozambique currently applies a 20 percent import tariff on maize flour, while only applying a 2.5 percent import tariff on maize grain imports. Mozambique has an additional import policy to further protect its industrial maize processors. The country applies a 17 percent Value Added Tax on all maize grain entering the country. The combination of the VAT and import tariff on grain equals the import tariff applied on maize flour, thus making it appear that Mozambique has high import barriers on all products rather than an escalating import tariff problem. However, further investigation into the VAT reveals that the 17 percent VAT is reimbursed as long as the grain is being imported to be processed into maize flour by an industrial processing company. On the other hand, if the grain being imported for use at smaller hammer mills or homes, then the VAT is not reimbursed. Therefore, the combination of a high escalating import tariff on maize flour, combined with a high VAT on maize grain that is exempt for industrial maize processors further illustrates the Mozambique government's protection of the industrial maize millers in the country.

A partial spatial equilibrium model was used to measure the changes in social welfare that occur due to a removal of the escalating import tariffs and VAT on South African imports of maize and maize flour. To make the model operational, domestic supply and demand elasticities were estimated for each region and used to calculate the excess supply and demand elasticities, slopes, and intercepts. A baseline was run and compared to the observed data to determine the accuracy of the model. In addition, through the sensitivity analysis of the estimated elasticities, the model was also determined to be resilient to small changes further indicating its robustness and accuracy for simulating the change in tariff policy.

The model was used to simulate three scenarios. The first examined the removal of the VAT. The results indicated little change in import or export prices and quantities, due to the small increase (30 Meticals) in southern Mozambique's import maize grain price as compared to South African export price of maize grain from the application of the VAT. The largest gainers were maize producers in South Africa, with an 8 percent increase in exports of maize grain.

The second scenario was the removal of the import tariffs on both maize grain and maize flour. The simulated results indicated sizeable declines in import prices, specifically maize flour, while export prices declined slightly. Export quantities of maize grain and maize flour from South Africa increased considerably (21.3 and 14.32 percent respectively), while decreases (3.23 percent) in movement of maize grain from central to southern Mozambique occurred but to a lesser degree. The removal of the import tariff escalation causes consumers in southern Mozambique and maize producers and millers in

South Africa to be better off, while central and southern Mozambique millers and central Mozambique producers are worse off.

The final scenario, free trade (removal of both the VAT and import tariffs), results were similar to the tariff removal results, just more extreme for maize grain prices and quantities traded. Import and export grain prices decline to a greater degree, than in either of the prior scenarios, in addition to higher imports of maize grain from South Africa (30 percent increase from the baseline). Consumers in southern Mozambique and maize producers and millers in South Africa are again better off under this scenario, as compared to the status quo, while central and southern Mozambique millers are the most negatively affected due to increased competition from South African maize flour imports (increase of 14.32 percent) at considerably lower prices (decrease of 20.51 percent). Although central Mozambique maize producers would experience slightly lower prices and 'export' demand to the south, the decrease in both quantity and price would be less than 6 percent for both.

7.2 Limitations

The econometric estimation of the domestic supply and demand elasticities had two limitations. The first and most important was a short data set, which decreased the accuracy of the elasticity estimates and caused them to be highly sensitive to small changes within the sample. In addition, data on consumption of maize flour were not available for Mozambique and thus the data had to be constructed using available GDP per capita, maize flour prices and expenditure allocated to maize and maize flour. The construction of the consumption data were restricted by applying the 1996 expenditure of maize and maize flour to the entire time sample, not allowing the percentage of expenditure to vary across years. Gross Domestic Product was also only available on a country level, decreasing the accuracy of the regional analysis. The construction of the consumption of maize flour led to high correlations between the dependent per capita maize flour consumption variable and the explanatory variables including GDP and maize flour. A time trend was used to decrease the correlation, however, multicollinearity still existed in the econometric estimation leading to lower confidence in the elasticity estimates. However, with sensitivity tests of the elasticities and comparison of the elasticities with previous studies, it is believed that suitable elasticity estimates were used given the data available.

A few assumptions were made in the social welfare model that should be noted. The first is that this model ignores seasonality of maize exports from South Africa and analyzes the issue on an annual basis. Typically imports are used to fulfill consumption needs when domestic production is depleted. However, due to South African institutions, little maize grain is available to be imported directly into the market. Instead, formal maize traders deal only with large industrial buyers. In addition, little informal trade of maize grain occurs since South African institutions also restrict maize grain availability on their domestic market. Tschirley and Abdula (2007) also note that the southern Mozambique industrial maize flour processors typically import grain from South Africa instead of transferring grain from the center to southern Mozambique. The institutions of South Africa combined with the constant demand of imported maize grain from southern Mozambique maize millers considerably decrease the importance of seasonal variation.

The net monetary social welfare model also assumes that the excess supply/demand elasticities of maize grain and maize flour are equal. These elasticities are likely to differ. Due to data constraints, excess elasticities were calculated for maize grain. It is hypothesized that maize grain elasticities are lower than maize flour elasticities, causing the simulated results for maize flour to be underestimated.

Finally, the net monetary social welfare model assumes homogeneity of the goods being traded. This model assumed the highest quality of maize flour and maize grain was being traded. Extraction rates of the highest noted maize flour quality from a 2005 survey of industrial processors in Mozambique (Abdula, 2005) and a published article on South African maize millers (Traub and Jayne, 2008) were used as sources. Qualities of the maize flour most likely still differ, due to the quality of maize grain used, which was not accounted for, and additives in the maize flour, typical of South African maize flour. However, since both southern Mozambique and South African millers use South African maize grain, the quality differs less. The quality of central Mozambique maize flour, although lower, is not relevant since only a small amount of maize flour is assumed to move from the center to the consumption zone in the south.

7.3 Implications

The simulation results indicate that consumers will be better off under a 'free-trade' policy, free of value added taxes and import tariff escalation, while domestic millers are worse off with higher input costs and lower market prices for maize flour, and center domestic maize producers experience neutral results. However, the dynamics of the maize trade between South Africa and the two Mozambique regions are complex and the slightest change, specifically in transportation or institutions, could result in differing results.

A key characteristic of Mozambique that this model has been built around is the fact that the northern region of Mozambique forms its own separate, natural maize market due to the lack of transport options across the Zambizi River. However, current construction is underway on a commercial bridge that would connect the north to the rest of the country at all times of the year and would no longer be impassable during high rains. The question becomes, if the bridge will increase flow of grain from the north to the center and south, thus decreasing the dependence on imports from South Africa? The bridge would most certainly increase the flow of grain from the north to the south, however, a cascading effect would almost certainly occur, as grain is dispersed in different locations as the truck heads south, therefore the actual additional quantity of grain introduced in the south would be unknown, until the degree the cascading effect is known. The bridge would for an integrated market, which would lead to an overall increase in efficiency. However, the distance between the main production zones in the north and consumption zones in the south still remain high (1800 km) and the overall transport cost, due in part to poor road quality, still remains high. In addition, demand for maize grain from Malawi still remains, where current northern Mozambique excess production goes.

Transport costs are high within Mozambique, at 1050 Meticals/t/km compared to 27 Meticals/t/km in South Africa. Although road quality remains a primary cause of high transport costs, the coordination of grain transport between producers and trucks also increases the cost. However, increase use of cell phones by producers and truck drivers is increasing coordination between producer and truck drivers, which in turn is decreasing transport cost. This decrease in transport cost will cause an overall decrease of central Mozambique maize grain price in the southern region and result with an increase in demand of maize grain.

Besides transport issues, institutions also have an effect on the results. The South African maize boards, although no longer used, still have lingering institutions that affect the export of maize grain to Mozambique. Although the model simulates the removal of the VAT, the model does not account for the fact that in South Africa maize grain is only sold by formal traders to large processors including exported maize. The large traders must find someone to buy the maize grain and they do not want to attempt to sell it in small quantities at the market in Mozambique. In addition, South Africa does not sell maize grain at the retail level, so informal traders cannot purchase the maize grain of the market in South Africa and transport it to the market in southern Mozambique. Therefore, even if the VAT has been removed, maize grain from South African will not flow onto the retail market due to the South African maize grain institutions. If the institutions were adjusted, and maize grain could either be exported by a formal or informal trader from South Africa, the increase of demand for South African maize grain already shown in the model simulations would most likely increase due to the availability of a cheaper maize grain option on the retail market.

Finally, current political situations restrict the movement of maize grain from central Mozambique into Zimbabwe. If institutional structures were to change and maize grain was able to move from central Mozambique to Zimbabwe, the assumption made that all grain from the center flows only to the southern region would no longer be accurate. If this occurred, the assumption is that there would be a decrease in the quantity of maize grain moving from the center to the south. This situation would cause tariff removal to be even more important as South Africa would now have to supplement the decrease in supply from the center. Although, bearing in mind that South Africa does not supply maize grain to the retail market, thus South Africa would only supply an increase of maize grain to the industrial processors to increase their maize flour production and/or South Africa could increase the supply of maize flour. In either case, urban consumers in southern Mozambique would have to adjust their consumption and buying patters to increase purchases of maize flour in place of their maize grain purchases.

7.4 Additional Research

Import tariff escalation as a south/south trade restriction should continued to be researched to further examine its impact on net social monetary welfare in developing country economies. Additional research that determines if and to what degree developing countries import tariff policies increase import prices, restrict import quantities and reduce domestic consumption would be valuable to increase the awareness of the possible negative monetary welfare effects import tariff escalation causes on domestic populations.

To reinforce the findings from this research, research on the net social monetary welfare impacts of import tariff escalation in different commodities within Mozambique should be conducted to verify that import tariff escalation increases consumer welfare and the removal of the policies increases supply from the exporting regions and decreases domestic prices. In addition, research on the effects of export tariff escalation in

Mozambique applied to cashews would add valuable analysis to two under-researched areas, south-south tariff escalation and export tariff escalation.

In Mozambique, further research should be conducted on the effects of the removal of import tariff escalation and the VAT which would allow for central Mozambique to be considered an importing region. The central region allocates a larger expenditure share to maize and maize derivates than the population in southern Mozambique, however, exports of maize grain and maize flour do not currently flow up to the center region. Therefore, it would be interesting to measure the effects on consumption in the center from the removal of the escalating tariffs and/or the VAT.

If data are available, analysis of the flow of grain at a quarterly or monthly level would allow for important seasonality implications to be uncovered. Nevertheless, if it remains as a yearly analysis, the research should be replicated in a few years to obtain more reliable domestic elasticity estimates and measure the changes in net social monetary welfare due to the removal of the escalating tariffs with the new elasticity estimates.

Finally, previous research indicates that the degree to which the commodity at different processing levels is affected from the removal of escalating import tariffs is also dependent on the availability of substitutes and the nature of competition. In southern Mozambique, the availability of substitutes is high and there are only two industrial maize flour processors in the region that occupy a majority of the market. Therefore, it would be valuable to conduct a study that consider both the degree of substitutability and nature of competition and determine their impact on the changes of prices and quantities from the removal of import tariff escalation.

APPENDICIES

APPENDIX A: VARIABLES OF SUPPLY/DEMAND ELASTICITY ESTIMATION

Table A.1: Variable Description: Southern Mozambique – Demand for Maize Flour

Variable	Unit	Source	Comment/Calculation
Dependent Variable			
QD_s^f	kg	Author Calculation	$QD_r^f = \left(\frac{GDP_r^{pc} \cdot EXP_r^w}{CP_r^f} \right) \cdot POP_r \backslash$ Sources: INE, IFA, SIMA
Explanatory Variables			
CP_s^f	04 Meticals/kg	SIMA	Maputo Market
CP_s^r	04 Meticals/kg	SIMA	Maputo Market

Table A.2: Descriptive Statistics: Southern Mozambique - Demand For Maize Flour

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Dependent Variable					
			(Kgs/Capita)		
QD_s^f	14	39.91786	7.495384	24.97	51.76
Explanatory Variables					
			(04 Meticals/Kg)		
CP_s^f	14	11.06714	2.628405	7.26	17.69
CP_s^r	14	10.58429	3.312212	7.41	18.9

Table A.3: Variable Description: Central Mozambique – Demand for Maize Flour

Variable	Unit	Source	Comment/Calculation
Dependent Variable			
QD_c^f	kg	Author Calculation	$QD_r^f = \left(\frac{GDP_r^{pc} \cdot EXP_r^w}{CP_r^f}\right) \cdot POP_r$ Sources: INE, IFA, SIMA
Explanatory Variables			
CP_c^f	04 Meticals/kg	SIMA	Beira Market
CP_c^r	04 Meticals/kg	SIMA	Beira Market

Table A.4: Descriptive Statistics: Central Mozambique – Demand for Maize Flour

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Dependent Variable					
			(Kgs/Capita)		
QD_c^f	15	63.66067	15.56037	44.56	98.97
Explanatory Variables					
			(04 Meticals/Kg)		
CP_c^f	15	10.79667	3.321038	5.5	18.97
CP_c^r	15	12.256	3.191804	8.63	19.01

Table A.5: Variable Description: Central Mozambique – Supply of Maize Grain

Variable	Unit	Source	Comment/Calculation
Dependent Variable			
QS_c^g	kg	Author Calculation	For 1992-2002: percent of production by region (FEWSNET 2006/2007) * total maize production 1992-99: FAO Production 2000-02: INE For 2003-2006: FEWSNET Food Balance Sheets
Explanatory Variables			
PP_c^g	04 Meticals/kg	SIMA	Manica prices, May to October
TTR	Millimeters	FEWSNET	Sussundeng Station (Manica Province) 1992-1994: Average rainfall 1995-2006 – standard deviation 1995-2006 1995-2006: Observed rainfall

Table A.6: Descriptive Statistics: Central Mozambique – Supply of Maize Grain

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Dependent Variable					
			(Million Kgs)		
QS_c^g	14	451	153	181	817
Explanatory Variables					
TTR (mm)	14	878.6743	223.5875	487	1292
PP_c^g (04 Meticals/Kg)	14	2.524286	0.8481175	1.34	5.12

Table A.7: Variable Description: South Africa – Demand for Maize Flour

Variable	Unit	Source	Comment/Calculation
Dependent Variable			
QD_a^f	kg	Author Calculation	$PROD + IMPORTS + STOR_s = CONSUMP + EXPORTS + STOR_e$ Sources: PROD – National Millers Association IMPORTS – United Nations STOR – assumed zero EXPORTS – United Nations
Explanatory Variables			
CP_a^f	04 Meticals/kg	SAGIS	Yr=May to April
GDP_a^{pc}	04 Meticals	World Bank	Development Indicators

Table A.8: Descriptive Statistics: South Africa – Demand for Maize Flour

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Dependent Variable					
			(Kgs/Capita)		
QD_c^f	7	59.36286	10.93665	46.25	75.02
Explanatory Variables					
GDP_a^{pc} (04 Meticals)	7	99963.71	9735.845	89096	115598
CP_a^f (04 Meticals/Kg)	7	12.84857	1.287781	11.67	14.91

Table A.9: Variable Description: South Africa – Supply of Maize Grain

Variable	Unit	Source	Comment/Calculation
Dependent Variable			
QS_a^g	kg	Author Calculation	1997-1999Abstract of Ag Stats (2008) total maize prod * 0.443 (FAO1996) – percent white maize 2000-2006 Ab of Ag Stats (2008) total maize prod * 0.633 (SA Transport) – percent white maize
Explanatory Variables			
FPP_a^g	04 Meticals/kg	SAFEX	Contract start date: November 15th, end July
FERT	04 Meticals	Ab of Ag Stats (2008)	Fertilizer Price Index

Table A.10: Descriptive Statistics: South Africa – Supply of Maize Grain

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Dependent Variable					
			(Billion kg)		
QD_c^f	10	5.43	1.43	3.48	7.43
Explanatory Variables					
			(Meticals/kg)		
CP_c^f	10	1.445	0.4290105	1.12	2.54
CP_c^r	10	84.649	22.36797	56.81	109.79

APPENDIX B: UNIT ROOTS DISCUSSION

Due to the descriptive properties of prices[20], prices tend to have stochastic trend (unit roots) causing the covariance to not be stationary, which violates basic econometric assumptions. Therefore, the data must be tested for unit roots. All prices and GDP data sets for all regions were tested for unit roots using the Dickey Fuller Test (Hamilton, 1994). All data sets were tested under two different conditions, first with a constant, and second with a constant and time trend (Table B.1).

In southern Mozambique, the Dickey Fuller test results failed to reject the null hypothesis that unit roots were in the data set with two lags with a Z(t) test statistic of -2.423, with an approximated p-value of 13 percent. However, additional lags did not result in a rejection of the null hypothesis either and actually moved the estimated p-value further from the significance levels needed to reject the null hypothesis. The data set were tested out to four lags, after which the number of observations in the data set did not allow for further testing. When the unit roots were tested for with the additional of a time trend, the results were consistent with the results found when only a constant was in the model. A two-lagged Dickey Fuller test provided the lowest estimated p-value of 29 percent with a Z(t) statistic of -2.570, while additional lags increased the p-value. The data were again lagged to the fourth degree, after which the number of observations did not allow for further testing. The price of rice was also tested for unit roots. The Dickey Fuller test results rejected the null hypothesis that unit roots were present in the data set at a 1 percent significance level with a Z(t) statistic of -6.809 with three lags when the

[20] Descriptive properties of prices include: high variability, co-movement, seasonality, time-varying volatility, unpredictability, and trends (Myers 2008b).

model was ran with a constant only. When the time trend was added and the test results indicated that the null hypothesis could not be rejected at a 10 percent level with up to four lags, after which the number of observations did not allow for further testing.

As in southern Mozambique, the price of maize flour and price of rice, in addition to the price of maize grain in central Mozambique were tested for unit roots. The tests results for the maize flour when only a constant was added, the null hypothesis was rejected that unit roots were in the model at a 5 percent significance level with a Z(t) statistic of -3.640 with three lags. When a time trend was added, the results were similar, with rejection of the null hypothesis at a 1 percent significance level with a Z(t) statistic of -3.936 with three lags. When the price of rice for central Mozambique was tested for unit roots using a constant only, the Dickey Fuller test found that the null hypothesis could be rejected at a 10 percent significance level with a Z(t) statistic of -3.22 when three lags were used. The addition of a time trend to the test found that the null hypothesis that unit roots were in the model could be rejected at a 1 percent significance level with a Z(t) statistic of -4.185 with one lag. The price of maize grain, used in the supply elasticity estimation for central Mozambique was also tested for unit roots. The Dickey Fuller test results for this data set indicated that with a constant only, the null hypothesis was rejected at a 1 percent significance level with a Z(t) statistic of -4.894 with one lag. When the test was ran with a time trend the results mirrored the previous results, in that the null hypothesis was rejected at a 5 percent level with a Z(t) statistic of -4.261 with one lag.

Table B.1: Dickey Fuller Test Results, (Continued)

	Z(t) Stat	Significance Level		
		1%	5%	10%
Southern Mozambique				
Price of Maize Flour				
Constant: 2-lags	-2.423	-3.75	-3.0	-2.63
Time Trend: 2-lags	-2.570	-4.38	-3.6	-3.24
Constant: 4-lags	-0.959	-3.75	-3.0	-2.63
Time Trend: 4-lags	-2.92	-4.38	-3.6	-3.24
Price of Rice				
Constant: 3-lags	-6.809	-3.75	-3.0	-2.63
Time Trend: 4-lags	-1.433	-4.38	-3.6	-3.24
Central Mozambique				
Price of Maize Flour				
Constant: 3-lags	-3.640	-3.75	-3.0	-2.63
Time Trend: 3-lags	-3.936	-4.38	-3.6	-3.24
Price of Rice				
Constant: 3-lags	-3.243	-3.75	-3.0	-2.63
Time Trend: 1-lag	-4.185	-4.38	-3.6	-3.24
Price of Maize Grain				
Constant: 1-lag	-4.894	-3.75	-3.0	-2.63
Time Trend: 1-lag	-4.261	-4.38	-3.6	-3.24

Source: Estimated by Author using secondary data sources.

Table B.1: Continued

	Z(t) Stat	Significance Level		
		1%	5%	10%
South Africa				
GDP				
Constant: 1-lag	1.413	-3.75	-3.0	-2.63
Time Trend: 1-lag	-0.369	-4.38	-3.6	-3.24
Price of Maize Flour				
Constant: 1-lag	-1.883	-3.75	-3.0	-2.63
Time Trend: 1-lag	-8.155	-4.38	-3.6	-3.24
Price of Maize Grain				
Constant: 1-lag	-2.091	-3.75	-3.0	-2.63
Constant: 3-lags	-1.399	-3.75	-3.0	-2.63
Time Trend: 3-lags	-8.588	-4.38	-3.6	-3.24

Source: Estimated by Author using secondary data sources

The South African GDP, maize flour price, and futures maize grain prices were all tested for unit roots as well. The Dickey Fuller test results for both a constant only and the addition of a time trend failed to reject the null hypothesis at a 10 percent level with one lag. Dickey Fuller tests with additional lags was not an option, as the number of observations did not allow for additional lags. When the price of maize flour was tested for unit roots with only a constant the test results indicated that with one lag the null hypothesis was rejected at a 1 percent level that the data contained unit roots. However, when a time trend was added, the results failed to reject the null hypothesis at a 10 percent significance level. As with the GDP data set, additional tests with added lags could not be done due to the number of observations in the data set. Finally, the South

African futures maize grain prices were tested for unit roots. The Dickey Fuller test indicated that with a constant only the results failed to reject the null hypothesis that unit roots were in the data with three lags. As with previous data sets, additional tests with added lags were not possible due to the number of observations in the data set. However, when a time trend was added, the test results indicated that the null hypothesis could be rejected at a 1 percent level with a Z(t) statistic of -8.588 when three lags were used.

Based on the results of the Dickey Fuller Test, which indicated that generally unit roots were present in at least one lag of the data, ARMA models, which were lagged based on the Dickey Fuller Test results, were ran to estimate the elasticities. Table B.2 shows the estimation results for the demand for maize flour in southern Mozambique using a three-lag ARMA model. The maize flour price elasticity using this estimation method is -1.02, which is slightly more inelastic than the OLS estimated elasticity of -0.89, however both are statistically significant at the 1 percent level. The remaining variables estimated in the model are all significant at the 5 percent level or less and are very similar (with in 0.1) to the OLS estimated values.

Table B.2: Southern Mozambique Demand Estimation, ARMA Model

Dependent Variable = Consumption of Maize Flour, kgs/capita			
Explanatory Variable	Coefficient	Z-Stat (P-*Value*)	Significance
Price of Maize Flour, Meticals/kgs	-1.02	-9.27 (0.0)	***
Price of Rice, Meticals/kgs	0.32	2.33 (0.20)	**
Time Trend	0.03	4.29 (0.00)	***
Constant	5.12	18.11 (0.0)	***
Chi^2-Stat	389.15		
Prob > Chi^2	0.000		

Source: Estimated from secondary data source
Note: Number of observations 14. All estimates in log-log form.
* Significance at the 10 percent level
** Significance at the 5 percent level
*** Significance at the 1 percent level

Using a three-lag ARMA model, the demand for maize flour in central Mozambique was estimated (Table B.3). The estimation results indicate that the estimated price elasticity of maize flour is -0.48, which is slightly more elastic (in absolute terms) than the OLS estimated price elasticity of maize flour, -0.33. The ARMA estimated elasticity of maize flour, like the OLS estimation, is not statistically different from zero. The additional variables estimated in the demand function remain similar to the OLS estimated values (within 0.2), however no additional parameters are statistically different from zero, except the constant which is consistent with the OLS estimation.

Table B.3: Central Mozambique Demand Estimation, ARMA Model

Dependent Variable = Consumption of Maize Flour, kg/capita			
Explanatory Variable	Coefficient	Z-Stat (P-Value)	Significance
Price of Maize Flour, Meticals/kg	-0.48	-1.20 (0.23)	
Price of Rice, Meticals/ kg	0.46	0.66 (0.51)	
Time Trend	-0.01	-0.39 (0.70)	
Constant	4.24	3.57 (0.0)	***
Chi^2-Stat	172.30		
Prob > Chi^2	0.000		

Source: Estimated from secondary data source
Note: Number of observations 15. All estimates in log-log form.
* Significance at the 10 percent level
** Significance at the 5 percent level
*** Significance at the 1 percent level

The supply of maize grain in central Mozambique was estimated, based on the results from the Dickey Fuller test, with a one-lag ARMA model (Table B.4). The ARMA estimation shows the price elasticity of maize flour to be 0.22, which is slightly more elastic than the OLS estimate of maize grain elasticity, however, neither are statistically different from zero. The ARMA estimations of the additional parameters are within 0.1 of the OLS estimates and are all statistically significant at a 5 percent level or lower.

Table B.4: Central Mozambique Supply Estimation, ARMA Model

Dependent Variable = Production of Maize Grain, kgs			
Explanatory Variable	Coefficient	Z-Stat (P-Value)	Significance
Lagged Producer Price, Meticals/kg	0.22	0.89 (0.37)	
Total Rainfall, mm	0.55	1.96 (0.05)	**
Time Trend	0.09	4.94 (0.0)	***
Constant	15.27	7.35 (0.0)	***
Chi^2-Stat	32.56		
Prob > Chi^2	0.00		

Source: Estimated from secondary data sources
Note: Number of observations 15. All estimates in log-log form.
* Significance at the 10 percent level
** Significance at the 5 percent level
*** Significance at the 1 percent level

Even though there were not enough degrees of freedom to reject the null hypothesis that unit roots were not in the data, thus indicating the number of lags to use for the ARMA model the failure to reject the null at a 10 percent level with one lag indicates the presence of unit roots. Therefore the South African demand for maize flour was estimated using an ARMA model with the most lags possible for this data set, one. Table B.5 shows the estimation results for this ARMA model and indicates that the price elasticity of maize flour is -0.55, but is not statistically different from zero. The ARMA estimated elasticity of maize flour is, like all ARMA estimations thus far, slightly more elastic than the OLS estimated elasticity of -0.49. The GDP variable is slightly less price responsive with the ARMA model than the OLS estimation, but is no longer statistically different from zero.

Table B.5: Southern African Demand Estimation, ARMA Model

Dependent Variable = Consumption of maize flour, kg/capita			
Explanatory Variable	Coefficient	Z-Stat (P-Value)	Significance
Price of Maize Flour, Meticals /kg	-0.55	-0.04 (0.67)	
GDP per capita, Meticals/capita	-2.08	-2.85 (0.00)	***
Constant	29.45	2.59 (0.01)	***
Chi^2-Stat	27.36		
Prob > Chi^2	0.00		

Source: Estimated from secondary data sources
Note: Number of observations 7. All estimates in log-log form.
* Significance at the 10 percent level
** Significance at the 5 percent level
*** Significance at the 1 percent level

Finally, the supply of maize grain in South Africa was estimated using a 3-lag ARMA model (Table B.6). The estimated supply elasticity of maize flour using the ARMA model was 0.77, but not statistically different from zero. This estimation of supply elasticity of maize grain is considerably more elastic than the OLS estimation of 0.11, which was not statically different from zero. The additional parameters, specifically fertilizer are also considerably different, however, besides the constant, just like the OLS estimations, none of the additional ARMA estimates are statistically different from zero.

Table B.6: South African Supply Estimation, ARMA Model

Dependent Variable = Production of Maize Grain, kgs			
Explanatory Variable	Coefficient	Z-Stat (P-Value)	Significance
Future Price, Meticals/kg	0.78	0.97 (0.33)	
Fertilizer Price Index	0.99	0.86 (0.39)	
Time Trend	-0.08	-0.62 (0.54)	
Constant	19.07	6.08 (0.00)	***
Chi^2-Stat	478.67		
Prob > Chi^2	0.000		

Source: Estimated from secondary data sources
Note: Number of observations 11. All estimates in log-log form.
* Significance at the 10 percent level
** Significance at the 5 percent level
*** Significance at the 1 percent level

Although the Dickey Fuller test results indicated that unit roots were in the all the price data, at least through the first lag, and the estimated ARMA model elasticities seem reasonable, the OLS estimated elasticities are used in this research. This decision was made due to the critiques of the Dickey Fuller test and the characteristics of this data set. First, researchers main critique of the unit root tests, specifically the Dickey Fuller test, is its low power. In other words, the test tends to accept the null hypothesis that unit roots are present in the data, even when that is not the case. Critiques say the low power of the test is due not only to the size of the data set, but the time span of the data set. If a data set is spanned over 30 years as compared to 10 years, the data offers more explanatory power (Gujarati, 2003). In addition to the critiques that the test lacks power, the characteristics of this data set, specifically the low number of observations leads to decreased explanatory power of the data when unit roots are corrected for through a lagged ARMA model. Therefore, due to the short time span of the data and the overall loss of degrees of freedom with the use of the ARMA model to correct for the unit roots, combined with the overall observation that the estimated elasticities of the ARMA model were consistent with the OLS estimated elasticities, the OLS estimated elasticities were used. Although, the ARMA elasticities due help validate the accuracy of the OLS estimated elasticities. In addition, the ARMA elasticities were used as an alternative elasticity option in the sensitivity tests, which can be found in Appendix D.

APPENDIX C: VARIABLES/PARAMETERS OF SOCIAL WELFARE MAXIMIZATION MODEL

Table C.1: Variable/Parameter Description, Social Welfare Maximization Equation, (Cont'd)

Variable	Quantity	Unit	Source	Comment/Calculation
Consumption				
CON_a^f	2,421,159	MT	Author Calculation	$PROD + IMPORTS + STOR_s = CONSUMP + EXPORTS + STOR_e$ Sources: PROD – National Millers Association IMPORTS – United Nations STOR – assumed zero EXPORTS – United Nations
CON_c^f	258,265	MT	Author Calculation	$CON^f = \left(\frac{GDP_r^{pc} \cdot EXP_r^w}{CP_r^f}\right) \cdot POP_r$ Sources: INE, IFA, SIMA
CON_s^f	196,045	MT	Author Calculation	
Production				
$PROD_a^g$	4,395,567	MT	Author Calculation	1997-1999Abstract of Ag Stats (2008) total maize prod * 0.443 (FAO1996) – percent white maize 2000-2006 Ab of Ag Stats (2008) total maize prod * 0.633 (SA Transport) – percent white maize
$PROD_c^g$	628,840	MT	Author Calculation	For 1992-2002: percent of production by region (FEWSNET 2006/2007) * total maize production
$PROD_s^g$	151,680	MT	Author Calculation	1992-99 FAO Production 2000-02 INE For 2003-2006: FEWSNET Food Balance Sheets

Table C.1: Continued

Prices				
FOB_c^f	9301.93	04 Meticals/MT	SIMA	Biera Market – Warehouse prices
FOB_a^f	6136.70	04 Meticals/MT	SA Revenue Service	Total value of exports/ Total quantity exported
FOB_a^g	3034.66	04 Meticals/MT	Abstract of Ag Stats (2008)	Gross White Maize, yr=May to April
FOB_c^g	2342.56	04 Meticals/MT	SIMA	Producer prices in Chimoio, aggregate of May to October prices
CIF_s^f	7391.05	04 Meticals/MT	Authors Calculation	$TC_{as} + \left(ADVAL_{as}^f \cdot FOB_a^f\right)$
CIF_s^g	3140.12	04 Meticals/MT	Authors Calculation	$TC_{as} + \left(ADVAL_{as}^g \cdot FOB_a^g\right) + (VAT_{as}^g \cdot OPP_c^{vat} \cdot MN_c^{vat} \cdot FOB$
Extraction Rate				
ER_a	62.5	Percent	Traub (2004)	Super fine industrial meal
ER_c	80	Percent	Abdula (2005)	VONK
ER_s	65	Percent	Abdula (2005)	CIM – brand Top Score highest quality
Transport Cost				
TC_{as}	27.014	04 Meticals/MT	Cruz (2006)	Converted for distance of Nelspruit, to Maputo City
TC_{cs}	1050	04 Meticals/MT	SIMA	Distance of Chimoio to Maputo

Table C.1: Continued

Flow				
FL_{as}^{f}	2,628	MT	UN COMTRADE	
FL_{cs}^{f}	0	MT		Based on correspondence w/ Abdula (2008)
FL_{ws}^{f}	0	MT	UN COMTRADE	$FL_{ws}^{f} = FL_{as}^{f}$
FL_{as}^{g}	82,256	MT	UN COMTRADE	Assuming all imports are all white maize
FL_{cs}^{g}	257,743	MT	Authors Calculation	$FL_{cs}^{g} = QD_{s}^{g} - (PROD_{s}^{g} + FL_{as}^{g} + FL_{ws}^{g})$
FL_{ws}^{g}	25,183	MT	UN COMTRADE	Assuming all imports are all white maize
X_{a}^{f}	8832	MT	UN COMTRADE	
X_{a}^{g}	603,861	MT	UN COMTRADE	
M_{s}^{g}	107,439	MT	UN COMTRADE	
Tariffs				
$ADVAL_{as}^{f}$	20	Percent	Mozambique Trade	
$ADVAL_{as}^{g}$	2.5	Percent	Mozambique Trade	
IR_{s}	2	Percent	Ardnt et al (2001)	Specifically for the center/south of Mozambique
MN	3		Tschirley and Abdula (2008)	Number of months to have VAT returned to industrial millers on imported maize grain
VAT_{as}^{g}	17	Percent	Mozambique Trade	

Table C.1: Continued

Elasticities				
E_{ss}	0	Percent	Authors Estimation	See Chapter 5
E_{sc}	0.17	Percent	Authors Estimation	See Chapter 5
E_{sa}	0.13	Percent	Authors Estimation	See Chapter 5
E_{ds}	-0.87	Percent	Authors Estimation	See Chapter 5
E_{dc}	-0.33	Percent	Authors Estimation	See Chapter 5
E_{da}	-0.49	Percent	Authors Estimation	See Chapter 5
E_{esc}	0.799844	Percent	Authors Calculation	$E_{esc} = E_{sc}\left(\frac{PROD_c^g}{X_c^g}\right) - E_{dc}\left(\frac{\frac{1}{EC_c} \cdot CON_c^f}{X_c^g}\right)$
E_{esa}	4.15385	Percent	Authors Calculation	$E_{esa} = E_{sa}\left(\frac{PROD_c^g}{X_a^g}\right) - E_{da}\left(\frac{\frac{1}{EC_a} \cdot CON_a^f}{X_a^g}\right)$
E_{sds}	-0.735063	Percent	Authors Calculation	$E_{eds} = E_{ds}\left(\frac{\frac{1}{EC_s} \cdot CON_s^f}{M_s^g + FL_{cs}^g}\right) - E_{ss}\left(\frac{PROD_s^g}{M_s^g + FL_{cs}^g}\right)$

Table C.1: Continued

Slopes and Intercepts				
α_s^g	485,689	MT	Authors Calculation	$\alpha_s^g = CIF_s^g - \beta_s^g \cdot (M_s^g + FL_s^g)$
β_s^g	-65.572	Percent	Authors Calculation	$\beta_s^g = \frac{CIF_s^g}{M_s^g + FL_{cs}^g} \cdot \frac{1}{E_{sds}}$
α_s^f	4,561.48	MT	Authors Calculation	$\alpha_s^f = CIF_s^f - \beta_s^f \cdot (M_s^f + FL_s^f)$
β_s^f	-0.261462	Percent	Authors Calculation	$\beta_s^f = \frac{CIF_s^f}{M_s^f + FL_{cs}^f} \cdot \frac{1}{E_{sds}}$
γ_c^g	51,588.8	MT	Authors Calculation	$\gamma_c^g = FOB_c^g - \delta_c^g \cdot X_c^g$
δ_c^g	88.0038	Percent	Authors Calculation	$\delta_c^g = \frac{FOB_c^g}{X_c^g} \cdot \frac{1}{E_{esc}}$
γ_c^f	0.200156	MT	Authors Calculation	$\gamma_c^f = FOB_c^f - \delta_c^f \cdot X_c^f$
δ_c^f	0.0000859 869	Percent	Authors Calculation	$\delta_c^f = \frac{FOB_c^f}{X_c^f} \cdot \frac{1}{E_{esc}}$
γ_a^g	-1,904,487	MT	Authors Calculation	$\gamma_a^g = FOB_a^g - \delta_a^g \cdot X_a^g$
δ_a^g	826.566	Percent	Authors Calculation	$\delta_a^g = \frac{FOB_a^g}{X_a^g} \cdot \frac{1}{E_{esa}}$
γ_a^f	-27,854.8	MT	Authors Calculation	$\gamma_a^f = FOB_a^f - \delta_a^f \cdot X_a^f$
δ_a^f	5.97826	Percent	Authors Calculation	$\delta_a^f = \frac{FOB_a^f}{X_a^f} \cdot \frac{1}{E_{esa}}$

Table C.2: Parameter Description, Consumption Calculation for Mozambique

Variable	Quantity	Unit	Source	Comment/Calculation
EXP_c^w	8.24	Percent	Author Calculation	$EXP_r^w = \sum\{[(PPOP_p^{urban} \cdot 96EXP_p^{urban}) +$
EXP_s^w	13.75	Percent	Author Calculation	$(PPOP_p^{rural} \cdot 96PEXP_p^{rural})]\} \cdot \frac{POP_p}{POP_s}$
$96EXP_p^{urban}$	Varies by province	Percent	1996 IAF	Reported as percentage of food expenditure – adjusted to total expenditure
$96EXP_p^{rural}$	Varies by province	Percent	1996 IAF	Reported as percentage of food expenditure – adjusted to total expenditure
POP_c	4,588,003		INE	
POP_s	5,061,768		INE	
$PPOP_p^{urban}$	Varies by province	Percent	INE	
$PPOP_p^{rural}$	Varies by province	Percent	INE	
GDP_r^{pc}	5583.97	04 Meticals	INE	Expenditure GDP
CP_c^f	13.13	04 Meticals/kg	SIMA	Aggregate of Beira Market
CP_s^f	12.20	04 Meticals/kg	SIMA	Aggregate of Maputo City Market

APPENDIX D: SENSITIVITY ANALYSIS OF ESTIMATED SUPPLY/DEMAND ELASTICTITIES AND ‘EXPORT’ QUANTITIES

As briefly discussed in the model validly section of Chapter 6 (section 6.2.1.2), sensitivity tests were conducted on the model by making slight changes in both the domestic demand and supply elasticities and the quantity of maize flour traded between central and southern Mozambique. The sensitivity tests were ran for a couple of reasons. First was to verify the accuracy of the model. By making slight changes in both the elasticities and quantities of maize flour traded, the results indicate the robustness of the model to small changes. By illustrating the models resilience to small changes in the elasticities, the sensitivity tests also helps to provide confidence in the estimated elasticities, which is important due to the data constraints that occurred during the estimation of the domestic supply and demand elasticity estimation. Therefore, the sensitivity tests help to provide confidence in the estimated elasticities, in addition to the overall model.

Table D.1 contains the results for the sensitivity analysis on the estimated supply elasticities of maize grain with constant domestic demand elasticities of maize flour. Five of the six sensitivity runs are a variation of the different regional supplies being increased by 0.25 from the baseline (indicated by a bold elasticity). The sixth run uses assumed supply elasticities of maize grain from Cruz (2006). The results of the sensitivity tests are reported in total value or quantity and percent difference from the observed value. The sensitivity test runs for the variation in domestic supply elasticity for maize grain indicate the models overall resilience to small changes of the domestic supply elasticities of maize grain. Although the South African maize grain variable[21] appears to be more sensitive to changes of the supply elasticities than other variables, with the percent difference between the simulated and observed value ranging from 3 percent to 47 percent (absolute value), most variables stay within a 10 percent range of variation from the observed value. Sensitivity run 4 and 6 are considered the most accurate combinations of domestic supply elasticities due to their overall small variation from the observed prices and quantities.

In addition to the South African maize grain quantity, the central Mozambique 'export' maize flour quantity also shows considerable variability from the observed value and variability between elasticity changes. However, special note should be taken when interpreting this variable, as the observed value is actually an assumed value by the author. Originally the value was assumed to be zero, but the model required that the quantity be a positive integer, resulting in 1 MT of maize flour to be the "observed" quantity moving from central to southern Mozambique based on the current maize market structure in southern Mozambique (see section 2.1.4). Due to the assumption made and the considerable percent differences between the simulated and "observed" values, sensitivity tests were conducted on the quantity of maize flour flowing from the center to the southern region of Mozambique (Table D.4).

The model shows considerable differences between the central Mozambique FOB observed price of maize flour and the simulated price of maize flour. This is hypothesized to be due to the observed FOB maize flour price used for central Mozambique. Since maize flour rarely moves from central Mozambique to southern

[21] Due to the variation of this variable, it is shaded gray in all tables, including D.1

Mozambique the accuracy of the price used for this variable is weak. However, the implications of this are believed to be small considering that all simulations in the sensitivity tests estimate the value of the price of maize flour to be within the same range. Since the removal of the VAT and import tariffs are compared to the simulated baseline used, the changes in price due to the removal will not be the difference between the observed prices and simulated changes from a change in trade policy, but the comparison between the simulated baseline results and the simulated change in trade policy results.

Table D.2 illustrates the results of the sensitivity tests where domestic supply elasticity was held constant and domestic demand elasticity varied. Again indicated in bold within the table, 0.25 was added and subtracted from the estimated (baseline) domestic elasticities of maize grain for each region. A range of combinations were ran, including individual regional changes in demand elasticities of maize flour, while the other regions were held constant at the OLS estimated elasticity of demand.

Results from the sensitivity runs when 0.25 was added to the estimated domestic supply elasticity of maize flour, runs 7 through 10, exhibited more variation from the observed prices and quantities as compared to the baseline. When 0.25 was subtracted from the estimated demand elasticities of maize flour, runs 11 through 14, the simulated results seemed to be more consistent with the results found in the original simulated baseline results. South African export maize grain quantity also varied throughout this section of sensitivity tests more than other variables, ranging from 8 percent of the observed quantity to 57 percent of the observed quantity. The central Mozambique quantity and price of maize flour also varied considerably from the observed value in these runs, however, the simulated price of maize flour stayed within a 10 percent margin.

Run 13, where all the domestic demand elasticities for maize grain were increase by -0.25, was determined to be the 'best' run due to the least variation from the observed prices and quantities, excluding the South African maize grain quantity and central Mozambique maize flour price and quantity variables. Run 12, with a domestic demand for maize flour for southern Mozambique which was increased by -0.25, while the other regions domestic demand elasticities were held constant at the estimated baseline level, simulated the second best run with the least variation from the observed prices and quantities, again with the exclusion of the problem variables discussed above.

Table D.3 shows the results of the sensitivity tests for the simultaneous changes in the domestic demand and supply elasticities for each region, using the sensitivity runs with the least variation from Table D.1 and Table D.2. The table indicates each demand and supply elasticity used for each region. In addition, the heading of the column notes the table and run for each demand and supply elasticity grouping.

Runs 19, 20, 22, and 23 are the only sensitivity runs where both the supply and demand elasticities are changing from the baseline estimation, besides run 24 which uses the elasticities from the ARIMA model. Runs 19 and 20 use the same domestic demand elasticities (D.2-12) and there is little difference in the supply elasticities used, except run 20 uses a high (relative) supply elasticity of maize grain for South Africa. Both results show low percentages of variation between the simulated and observed prices. The percent differences between the observed and simulated quantities are overall less than the estimated baseline as well. The same comparison can be done between runs 22 and

23. The percentage differences between the simulated and observed values are similar to the results from runs 19 and 20. However, the quantity of maize grain from South Africa estimates continue to show their sensitivity to a change in supply and/or demand elasticities due to considerable variation across elasticities.

Overall the model appears to be resilient to small changes in the elasticities. Most variables show little variation when small changes in elasticities of either supply and/or demand are made. Considerable variation still occurs in the South African maize grain quantity traded variable, although little can be done since the observed value comes from a reliable source and the value was double checked against another source. The price of maize flour in central Mozambique remains problematic, but as discussed above, because all simulated prices are in the same area, this problem is believed to be with the observed value, not the model.

Since the quantity of maize flour from central to southern Mozambique was assumed to be 1 MT and the considerable variation that occurred during the sensitivity tests of the elasticities, the quantity of maize flour from central Mozambique was tested for sensitivity. Flow quantities from the center to the southern region of maize flour were increased for four different sensitivity runs. The results indicate that the model is not sensitive to an increase in quantity of maize flour traded under the baseline estimation as there was little variation in the simulated prices or quantities across the different sensitivity runs. More specifically, the percent difference between the simulated quantity and the observed quantity of maize flour traded to the center region did not notably change. The quantity of maize flour flowing from the center to the southern region of Mozambique was only increased to 500 MT of maize flour, however, that is 20 percent of the total maize flour imports for 2006 and it is therefore believed that 500 MT would be the maximum amount of maize flour flowing from the center to southern Mozambique, which is compatible when using Abdula (2008) belief that no more than 5 percent of maize flour comes from central Mozambique.

Table D.1:Sensitivity Analysis - Domestic Supply Variation, Values and Percent Difference from Observed Value, (Cont'd)

Variables	Observed Values	Baseline - Author Est.		Sensitivity Run 1 - Author Est. + 0.25		Sensitivity Run 2- Author Est. + 0.25		Sensitivity Run 3- Author Est. + 0.25		Sensitivity Run 4 - Author Est. + 0.25	
		SM **0** **CM** **0.17** **SA** **0.13**		**SM** 0 **CM** 0.17 **SA** **0.38**		**SM** 0 **CM** **0.42** **SA** 0.13		**SM** **0.25** **CM** 0.17 **SA** 0.13		**SM** **0.25** **CM** **0.42** **SA** **0.38**	
Prices (Met/MT)		**Value**	**Percent**	**Value**	**Percent**	**Value**	**Percent**	**Value**	**Percent**	**Value**	**Percent**
Southern Moz.											
Grain	**3,140**	**2,896**	***-7.77***	2,975	*-5.25*	2,858	*-8.99*	2,943	*-6.29*	2,974	*-5.28*
Flour	**7,391**	**7,170**	***-2.99***	7,239	*-2.06*	7,170	*-2.99*	7,261	*-1.76*	7,301	*-1.21*
Central Moz.											
Grain	**2,343**	**1,846**	***-21.19***	1,925	*-17.82*	1,808	*-22.83*	1,893	*-19.21*	1,924	*-17.85*
Flour	**9,302**	**6,120**	***-34.21***	6,189	*-33.47*	6,120	*-34.21*	6,211	*-33.23*	6,251	*-32.79*
South Africa											
Grain	**3,035**	**2,772**	***-8.67***	2,848	*-6.15*	2,734	*-9.89*	2,816	*-7.19*	2,847	*-6.18*
Flour	**6,137**	**5,953**	***-3.00***	6,010	*-2.07*	5,952	*-3.00*	6,028	*-1.77*	6,062	*-1.22*
'Export' Quantity (MT)											
Central Moz.											
Grain	**257,743**	**214,059**	***-16.95***	221,011	*-14.25*	177,226	*-31.24*	218,137	*-15.37*	194,793	*-24.42*
Flour	**1**	**0.73**	***-27.36***	0.73	*-26.77*	0.53	*-46.80*	0.73	*-26.58*	0.55	*-44.87*
South Africa											
Grain	**85,256**	**56,539**	***-33.68***	44,407	*-47.91*	95,895	*12.48*	50,749	*-40.48*	71,810	*-15.77*
Flour	**2,628**	**2,686**	***2.21***	2,668	*1.53*	2,686	*2.22*	2,665	*1.42*	2,654	*0.99*
Consumption (MT) – ***Southern Moz.***											
Flour	**196,046**	**194,945**	***-0.56%***	191,560	*-2.29*	196,584	*0.84*	193,811	*-0.58*	194,945	*-0.56*

Table D.1: Continued

Variables	Observed Values	Sensitivity Run 5 - Author Est. + 0.25		Sensitivity Run 6 - Cruz (2006)	
		SM **0.25**	CM **0.42** SA 0.13	SM **0.3** CM **0.45**	SA **0.65**
Prices (Met/MT)		Value	Percent	Value	Percent
Southern Moz.					
Grain	3,140	2,900	*-7.64*	3,023	*-3.72*
Flour	7,391	7,261	*-1.76*	7,335	*-0.76*
Central Moz.					
Grain	2,343	1,850.37	*-21.01*	1,973	*-15.76*
Flour	9,302	6,211	*-33.23*	6,285	*-32.44*
South Africa					
Grain	3,035	2,776	*-8.54*	2,894	*-4.62*
Flour	6,137	6,028	*-1.77*	6,090	*-0.77*
'Export' Quantity (MT)					
Central Moz.					
Grain	257,743	183,647	*-28.75*	199,393	*-22.64*
Flour	1	0.55	*-45.46*	0.53	*-46.59*
South Africa					
Grain	85,256	88,254	*3.52*	63,846	*-25.11*
Flour	2,628	2,666	*1.43*	2,645	*0.64*
Consumption (MT)					
Southern Moz.					
Flour	196,045	195,771	*0.42*	190,120	*-2.47*

Source: Estimated by Author.
Note: This sensitivity test holds the estimated domestic demand elasticities constant, SM=-0.87, CM=-0.33, SM=-0.5. Bold elasticity indicates a change from the baseline run

Table D.2: Sensitivity Analysis - Domestic Demand Variation, Values and Percent Difference from Observed Value, (Cont'd)

Variables	Observed Values	Sensitivity Run 7 - Author Est. + 0.25		Sensitivity Run 8 - Author Est. + 0.25		**Sensitivity Run 9 - Author Est. + 0.25**		**Sensitivity Run 10 - Author Est. + 0.25**		Sensitivity Run 11 - Author Est. -0.25	
		SM -0.89; SM **-0.64**; SM **-0.64**		CM **-0.08**; SA **-0.25**; SA -0.50		SM **-0.64**; CM -0.33; SA -0.50		SM **-0.64**; CM **-0.08**; SA **-0.25**		SM -0.89; CM **-0.58**; SA -0.50	
Prices (Met/MT)		**Value**	**%**	**Value**	**%**	**Value**	**%**	**Value**	**%**	**Value**	**%**
Southern Moz.											
Grain	**3,140**	2,733	*-12.98*	2,920	*-7.01*	2,759	*-12.15*	2,532	*-19.36*	2,874	*-8.47*
Flour	**7,391**	7,015	*-5.08*	7,170	*-2.99*	6,900	*-6.65*	6,566	*-11.16*	7,170	*-2.99*
Central Moz.											
Grain	**2,343**	1,683	*-28.17*	1,870	*-20.17*	1,709	*-27.06*	1,482	*-36.73*	1,824	*-22.12*
Flour	**9,302**	5,965	*-35.87*	6,120	*-34.21*	5,850	*-37.11*	5,516	*-40.70*	6,120	*-34.21*
South Africa											
Grain	**3,035**	2,614	*-13.87*	2,795	*-7.91*	2,639	*-13.05*	2,420	*-20.25*	2,750	*-9.37*
Flour	**6,137**	5,824	*-5.10*	5,953	*-3.00*	5,727	*-6.67*	5,449	*-11.20*	5,952	*-3.00*
'Export' Quantity (MT)											
Central Moz.											
Grain	**257,743**	199,669	*-22.53*	232,440	*-9.82*	201,952	*-21.65*	211,669	*-17.88*	194,274	*-24.62*
Flour	**1**	0.71	*-28.69*	0.83	*-16.65*	0.70	*-29.68*	0.80	*-19.81*	0.62	*-38.07*
South Africa											
Grain	**85,256**	81,652	*-4.23*	36,591	*-57.08*	70,769	*-16.99*	71,720	*-15.88*	**77,760**	***-8.79***
Flour	**2,628**	2,727	*3.75*	2,686	*2.21*	2,721	*3.53*	2,783	*5.91*	2,686	*2.21*
Consumption (MT) – ***Southern Moz.***											
Flour	**196,046**	201,955	*3.01*	193,926	*-1.08*	196,359	*0.16*	203,356	*3.73*	195,878	*-0.09*

Table D.2 Continued[22]

Variables	Observed Values	Sensitivity Run 12 - Author Est. - 0.25		**Sensitivity Run 13- Author Est. - 0.25**		**Sensitivity Run 14 - Author Est. -0.25**		**Sensitivity Run 15 - SM=-0.5**	
		SM **-1.14**, CM -0.33, SA -0.50		SM **-1.14**, CM **-0.58**, SA **-0.75**		SM **-1.14**, CM **-0.58**, SA -0.50		SM **-0.50**, CM -0.33, SA -0.50	
Prices (Met/MT)		**Value**	**%**	**Value**	**%**	**Value**	**%**	**Value**	**%**
Southern Moz.									
Grain	**3,140**	3,040	*-3.19*	3,054	*-2.75*	3,011	*-4.10*	2,684	*-14.51*
Flour	**7,391**	7,451	*0.81*	7,433	*0.57*	7,451	*0.81*	6,753	*-8.64*
Central Moz.									
Grain	**2,343**	1,990	*-15.05*	2,004	*-14.47*	1,961	*-16.27*	1,634	*-30.23*
Flour	**9,302**	6,401	*-31.19*	6,383	*-31.38*	6,401	*-31.19*	5,703	*-38.69*
South Africa									
Grain	**3,035**	2,910	*-4.09*	2,924	*-3.66*	2,883	*-5.00*	2,567	*-15.41*
Flour	**6,137**	6,187	*0.81*	6,172	*0.57*	6,186	*0.81*	5,605	*-8.67*
'Export' Quantity (MT)									
Central Moz.									
Grain	**257,743**	226,711	*-12.04*	216,242	*-16.10*	211,070	*-18.11*	195,417	*-24.18*
Flour	**1**	0.35	*-64.98*	0.65	*-34.92*	0.65	*-34.71*	0.29	*-70.98*
South Africa									
Grain	**85,256**	**36,441**	***-57.26***	**45,759**	***-46.33***	**54,476**	***-36.10***	**76,104**	***-10.73***
Flour	**2,628**	2,609	*-0.74*	2,614	*-0.52*	2,608	*-0.75*	2,722	*3.59*

[22] Source: Estimated by Author.

Note: This sensitivity test holds the estimated domestic supply elasticities constant, SM=0, CM=0.17, SA=0.13

Table D.3:Sensitivity Analysis - Domestic Supply/Demand Variation, (Cont'd)

Variables	Observed Values	Baseline - Author Est.			Sensitivity Run 16			Sensitivity Run 17		
					S: D.1(4)		***D: Baseline***	***S: Baseline***		***D: D.2(13)***
		SM	CM	SA	SM	CM	SA	SM	CM	SA
	Supply	0	0.17	0.13	0.25	0.42	0.38	0	0.17	0.13
	Demand	-0.89	-0.33	-0.50	-0.89	-0.33	-0.50	-1.14	-0.58	-0.75
Prices (Met/MT)		Value		%	Value		%	Value		%
Southern Moz.										
Grain	3,140	2,896		*-7.77*	2,974		*-5.28*	3,054		*-2.75*
Flour	7,391	7,170		*-2.99*	7,301		*-1.21*	7,433		*0.57*
Central Moz.										
Grain	2,343	1,846		*-21.19*	1,924		*-17.85*	2,004		*-14.47*
Flour	9,302	6,120		*-34.21*	6,251		*-32.79*	6,383		*-31.38*
South Africa										
Grain	3,035	2,772		*-8.67*	2,847		*-6.18*	2,924		*-3.66*
Flour	6,137	5,953		*-3.00*	6,062		*-1.22*	6,172		*0.57*
'Export' Quantity (MT)										
Central Moz.										
Grain	257,743	214,059		*-16.95*	194,793		*-24.42*	216,242		*-16.10*
Flour	1	0.73		*-27.36*	0.55		*-44.87*	0.65		*-34.92*
South Africa										
Grain	85,256	56,539		*-33.68*	71,810		*-15.77*	45,759		*-46.33*
Flour	2,628	2,686		*2.21*	2,654		*0.99*	2,614		*-0.52*
Consumption (MT)										
Southern Moz.										
Flour	196,045	194,945		*-0.56*	190,120		*-2.47*	189,284		*-3.45*

Table D.3: Continued

Variables	Observed Values	Sensitivity Run 19			Sensitivity Run 16			Sensitivity Run 17		
		S: D.1(4)	***D: D.2(13)***		***S: D.1(6)***	***D: D.2(13)***		***S: Baseline***	***S: D.2(12)***	
		SM	SM	SM	SM	CM	SA	SM	CM	SA
	Supply	0.25	0.42	0.38	0.3	0.45	0.65	0	0.17	0.13
	Demand	-1.14	-0.58	-0.75	-1.14	-0.58	-0.75	-1.14	-0.33	-0.50
Prices (Met/MT)		Value		%	Value		%	Value		%
Southern Moz.										
Grain	3,140	3,076		*-2.04*	3,095		*-1.43*	3,040		*-3.19*
Flour	7,391	7,472		*1.10*	7,463		*0.97*	7,451		*0.81*
Central Moz.										
Grain	2,343	2,026		*-13.51*	2,045		*-12.69*	1,990		*-15.05*
Flour	9,302	6,422		*-30.96*	6,413		*-31.06*	6,401		*-31.19*
South Africa										
Grain	3,035	2,945		*-2.94*	2,964		*-2.33*	2,910		*-4.09*
Flour	6,137	6,204		*1.10*	6,196		*0.97*	6,187		*0.81*
'Export' Quantity (MT)										
Central Moz.										
Grain	257,743	199,185		*-22.72*	200,508		*-22.21*	226,711		*-12.04*
Flour	1	0.48		*-52.05*	0.46		*-54.34*	0.35		*-64.98*
South Africa										
Grain	85,256	61,325		*-28.07*	58,328		*-31.58*	36,441		*-57.26*
Flour	2,628	2,599		*-1.09*	2,602		*-0.97*	2,609		*-0.74*
Consumption (MT)										
Southern Moz.										
Flour	196,045	188,301		*-4.11*	187,216		*-4.50*	190,026		*-3.07*

Table D.3: Continued

Variables	Observed Values	Sensitivity Run 22			Sensitivity Run 23			Sensitivity Run 24		
		S: D.1(4)	***D: D.2(12)***		***S: D.1(6)***	***D: D.2(12)***		***ARIMA Estimates***		
		SM	SM	SM	SM	CM	SA	SM	CM	SA
	Supply	0.25	0.42	0.38	0.3	0.45	0.65	0	0.22	0.78
	Demand	-1.14	-0.33	-0.50	-1.14	-0.33	-0.50	-1.02	-0.48	-0.55
Prices (Met/MT)		Value		%	Value		%	Value		%
Southern Moz.										
Grain	3,140	3,073.30		*-2.13*	3,097		*-1.36*	3,064		*-2.4*
Flour	7,391	7,495		*1.41*	7,478		*1.17*	7,358		*0.0*
Central Moz.										
Grain	2,343	2,023		*-13.63*	2,047		*-12.60*	2,014		*-14.03*
Flour	9,302	6,445		*-30.71*	6,428		*-30.90*	6,308		*-32.19*
South Africa										
Grain	3,035	2,943		*-3.03*	2,966		*-2.27*	2,934		*-3.30*
Flour	6,137	6,224		*1.42*	6,209		*1.18*	6,109		*0.0*
'Export' Quantity (MT)										
Central Moz.										
Grain	257,743	209,680		*-18.65*	211,079		*-18.10*	217,917		*-15.45*
Flour	1	0.58		*-42.02*	0.56		*-44.38*	0.645		*-35.50*
South Africa										
Grain	85,256	51,076		*-40.09*	47,567		*-44.21*	42,549		*-50.0*
Flour	2,628	2,591		*-1.41*	2,597		*-1.18*	2,638		*-0.0*
Consumption (MT)										
Southern Moz.										
Flour	196,045	188,452		*-3.87*	187,087		*-4.57*	188,311		*-3.40*

Source: Estimated by Author.

Table D.4: Sensitivity Analysis - Central Mozambique Flour 'Exports'

Variables	Observed Values	Baseline - Author Est.		Sensitivity Run 25		**Sensitivity Run 26**		**Sensitivity Run 27**		**Sensitivity Run 28**	
		FLFAS=1		FLFCS=50		FLFCS=150		FLFCS=300		FLFCS=500	
Prices (Met/MT)		**Value**	**%**	**Value**	**%**	**Value**	**%**	**Value**	**%**	**Value**	**%**
Southern Moz.											
Grain	**3,140**	2,896	*-7.77*	2,896	*-7.77*	2,896	*-7.77*	2,896	*-7.77*	2,896	*-7.77*
Flour	**7,391**	7,170	*-2.99*	7,160	*-3.13*	7,139	*-3.41*	7,108	*-3.83*	7,067	*-4.39*
Central Moz.											
Grain	**2,343**	1,846	*-21.19*	1,846	*-21.19*	2,896	*-21.19*	1,846	*-21.19*	1,846	*-21.19*
Flour	**9,302**	6,120	*-34.21*	6,1010	*-34.32*	7,160	*-34.54*	6,058	*-34.88*	6,017	*-35.32*
South Africa											
Grain	**3,035**	2,772	*-8.67*	2,772	*-8.67*	2,772	*-8.67*	2,772	*-8.67*	2,772	*-8.67*
Flour	**6,137**	5,953	*-3.00*	5,944	*-3.14*	5,927	*-3.42*	5,901	*-3.85*	5,866	*-4.40*
'Export' Quantity (MT)											
Central Moz.											
Grain	**257,743**	214,059	*-16.95*	214,059	*-16.95*	214,059	*-16.95*	214,059	*-16.95*	214,059	*-16.95*
Flour	**1**	0.73	*-27.36*	36	*-27.45*	109	*-27.63*	216	*-27.89*	0.62	*-38.07*
South Africa											
Grain	**85,256**	56,539	*-33.68*	56,539	*-33.68*	56,539	*-33.68*	56,539	*-33.68*	56,539	*-33.68*
Flour	**2,628**	2,686	*2.21*	2,653	*0.96*	2,586	*-1.58*	2,487	*-5.37*	2,355	*-10.39*
Consumption (MT) – ***Southern Moz.***											
Flour	**196,046**	194,945	*-0.56*	194,947	*0.00*	194,953	*0.00*	194,961	*0.01*	194,972	*0.01*

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