WELFARE ANALYSIS IN INTERNATIONAL SUGAR TRADE: THE CASE OF THE EU-ACP SUGAR PROTOCOL

By

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“To my family”

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ACP	African Caribbean and Pacific group of countries
EBA	Everything But Arms
CMO	Common Market Organization
EC	European Commission
EPA	Economic Partnership Agreement
EU	European Union
FAS	Foreign Agricultural Service of the United States Department of Agriculture
GAMS	General Algebraic Modeling System
GATT	General Agreement on Tariffs and Trade
GSP	Generalized System Tariff
HFCS	High Fructose Corn Syrup
LDC	Least Development Country
MFA	Multi Fiber Agreement
MMT	Million Metric Tons
MSN	Maximum Supply Needs
UNCTAD	United Nations Conference on Trade and Development
USDA	United States Department of Agriculture
STABEX	Stabilization of Export Earnings
TRQ	Tariff Rate Quota
WTO	World Trade Organization

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The European Union (EU) Common Agricultural Policy for sugar has evolved since the 1960s and what has evolved is a costly supply management scheme which insulates domestic producers from international competition by means of a system of price supports and prohibitive import tariffs. There is evidence from sugar price data that the policies that were followed by the EU have resulted in domestic prices three times higher than world free market prices. Excess supply has been exported to the world markets using expensive market distorting subsidies. Part of the supply management scheme involved granting duty free access for certain amounts of sugar from the African, Caribbean and Pacific countries (ACP), a block made up of mostly former British and French colonies.

Following a complaint by Australia, Brazil and Thailand in 2002, claiming that the volume of the EU's subsidized exports of sugar exceeded the levels the EU had committed itself under the Uruguay Round Agreements, a World Trade Organization (WTO) panel ruled in favor of the three complainants. The EU was then obliged to bring its domestic market regulation into conformity with its WTO obligations. To be compliant

with WTO regulations, in 2005 the European Agricultural Council agreed to a set of reforms that were to result in a 36% price cut.

Given that most ACP countries have agriculturally based economies, any agricultural sector that guarantees the economy a steady influx of foreign exchange is critical and needs to be cultivated. The study is a world sugar trade model to understand the effects of EU sugar policy reform on world production and how it would affect sugar production in the ACP countries and the rest of the world, and what the effects of reforms are on world sugar prices, production and consumption. Results indicate that liberalization might be beneficial to some members of the ACP countries, which is contrary to what other studies have suggested.

CHAPTER 1
INTRODUCTION

Background

A Historical Overview

Sugar is a product of photosynthesis that occurs in all green plants as carbohydrates. Two crops are the main sources of commercial sucrose. They are sugar cane (*Saccharum officinarum*), a perennial grass mostly grown in tropical countries and sugar beet (*Beta vulgaris*) which is a beet root variety mostly grown in cold climates. The sugar cane plant, according to Clarke (1988), is the most efficient collector of solar energy in the plant kingdom, fixing 2% of available solar energy into sucrose. It is the ability of cane and beet to store large amounts of carbohydrates in their stems and roots, respectively, that their juices are rich in pure sucrose.

According to a European Commission (EC) Report (2004), sugar contained in beet or cane is extracted by dissolving it in water and the resulting juice concentrated into sugar syrup that eventually crystallizes after saturation. Plant waste impurities retained on crystallization color the sugar brown, and it has a sweetening power less than that of white sugar. Refining involves eliminating these impurities to less than 0.5% to obtain perfectly white sugar. Raw beet sugar is not useable as such since the impurities give it a disagreeable taste, thus the industrial processing of beet is always to the white sugar stage of the marketed product. Raw cane sugar, on the other hand, can be ingested. The impurities give it a particular taste, and with it some nutritional value and a natural product image that is desirable to some consumers. World trade in cane sugar is primarily at the raw sugar stage (EC Report, 2004).

There are historical indications that Europe has been engaged in sugar trade dating back to the era of Alexander the Great around 327 B.C. (Laszlo, and Rizzuto, 1990). Other trade examples include sugar being brought in by Arab armies across the north coast of Africa possibly into Spain and Sicily around 700 A.D. In 1100, first samples of the Persian reed, as it was also known then, reached Britain, brought back by returning crusaders, but it was not until the early fourteenth century that sugar started arriving in sufficient quantities to be readily available to the public (Spence, 1997). The first regular trade in sugar to Britain began in 1319 when some Venetian traders started erratic shipments making sugar available only to the rich.

Sugar beet cultivation and extraction of sugar from the plant is a much more recent development that occurred in the 18th century. A white-colored beet called the “Beta Maritima” had been grown in Mediterranean countries for ages, but it was not until 1590 that Oliver De Serres prepared a syrup from beets and noted that the “juice yielded on boiling is similar to sugar syrup” (Laszlo and Rizzuto, 1990). Later in 1748, a German scientist Andreas Sigismund Marggraf became interested in its “sweet root” properties. During his laboratory tests he succeeded in extracting sugar from thin slices of beets, using alcohol, and crystallizing it. Not much was done of it until a student of Marggraf, Franz Carl Achard, wrote a report detailing how he had separated a significant amount of sugar. The report was presented to the King of Prussia, resulting in the first beet factory being built and the subsequent commercialization of the crop in 1801 (Laszlo, and Rizzuto, 1990; Spence, 1997).

The Napoleonic wars at the end of the 18th century disrupted what had become a developed flow of sugar from the Western hemisphere to Europe, which had accounted for 12 million tons of sugar between 1690 and 1790. Specifically, the Napoleonic wars and the continental blockade in 1806 prevented sugar from England and its colonies from entering the rest of Europe. Since most of the supply of sugar in Europe was imported cane sugar, shortages due to the war, led to a push for the development of a large scale beet sugar industry. Sugar beet production also grew as a result of market interventions that increased the landed price of sugar imported from colonies. For 300 years, European countries strictly regulated the trade in sugar to facilitate taxation of their sugar producing colonies (Ballinger, 1971). Since colonies were forced to export exclusively to mother countries, sugar tariffs created an indirect incentive for the beet industry to mushroom, and as the industry grew, it was in its best interest to ensure that taxes were maintained on sugar entering European and North American markets, hence maintaining market distortions for decades (Borrell and Duncan, 1993).

Over the past four decades, sugar trade in Europe has been dominated by the Common Market Organization (CMO) which was established in 1968 and whose main goal was ensuring a fair income to community producers and self-sufficiency of the community market and that imports were accommodated under a special system for African, Caribbean and Pacific (ACP) nations.

Why Study Sugar

There is widespread agreement that ever since sugar was introduced to the western world over 400 years ago, the sugar industry experiences the most government intervention among a set of soft commodities. Some governments have over time provided generous subsidies and increased the level of protection to keep the industry viable in view of its importance to the domestic economy, while others have nationalized it in order to raise revenue for public services. Nonetheless, government intervention and overall control of the industry has increased over the years, with the result that sugar is now a highly politicized commodity and sugar markets are one of the most distorted in the world (Abbot, 1990; Polopolus, 2002; Elobeid and Beghin, 2006).

Almost all the world's beet sugar supply is produced by developed countries, while cane sugar is produced primarily in developing countries. The result of this peculiar pattern is that the production of cane sugar is largely uncoordinated which tends to increase the unpredictability of output, by contrast, beet sugar production is subject to a series of policy directives, targets, and price formulae, all of which give the sugar industry stability and provide an incentive for expansion of output (Abbot, 1990). Marks and Maskus (1993) contend that sugar stands out because it has historically been one of the few agricultural commodities that could be produced in both temperate and tropical climates, with low-income and high-income countries potentially in direct competition with each other. Since the 1970s high fructose corn syrup (HFCS) has emerged as a popular substitute for liquid sugar in countries that grow or import corn. The substantial differences in the costs of production across countries and products have resulted in sugar being one of the most heavily protected farm commodities in the major developed countries of the northern hemisphere.

The production of cane sugar is essentially a two stage process, the first of which is a labor intensive operation, while the second is highly capital intensive. Furthermore, the second stage has two main centers of specialization. One located in developing countries, produces and exports raw sugar which is a low-value product. The other undertaken mainly in developed countries, produces and exports refined sugar which is a higher-value product. This creates serious discontinuities in the chain of production and limits developing countries' ability to influence and control the disposition of the final product. The production of beet sugar, being a highly integrated process, does not share the same disadvantages that cane sugar faces.

There has been a series of new developments which have profoundly altered the performance and outlook of the sugar industry (Abbot, 1990). Most of them date from 1974 when the world price of sugar rose to record levels and set off an expansion of output which, in turn caused prices to collapse and set the conditions for successfully negotiating the 1997 International Sugar Agreements. These modern developments are that (a) production continues to climb, while consumption remains constant or is falling in most of the world's major markets and (b) the drive for self-sufficiency, which accelerated after 1974, has reduced the amount of sugar traded internationally and has led to the development of protected domestic markets. Protectionism has led to a situation that in several countries, the domestic price of sugar bears no relation to world prices. Some authors (Abbot, 1990; Polopolus, 2002) for example, argue that the industry has in fact, surrounded itself with a super structure of protectionism which delays the process of structural adjustment. More seriously, it provided the conditions which enabled alternative sweeteners to develop to the point where they now pose a serious threat to the long term future of sugar.

It is the confluence of political and economic factors of rich and poor countries potentially at loggerheads with each other, the persistence of government policies such as tariffs, quotas and taxes on sugar, the potential welfare effects of possible policy changes that make research on the economics of sugar production and trade interesting.

World Sugar: Production, Domestic Consumption, Imports and Exports

Sugar is one of the most autarkic of soft commodities in the world, whose production spanned 120 countries by 1995 (Hannah and Spence, 1996). It is this desire for self-sufficiency that fueled the number of countries producing sugar especially after World War II. As a result world production expanded rapidly during the 1950s where it grew 5.6% annually between 1950/51 and 1955/56. During the latter half of that decade the rate of growth fell to 4.35% per annum, bringing world output to 55.4 million tons in 1960/61 (Abbot, 1990). Sugar production is spread all over the world, where three major producing areas are the Northern hemisphere beet producers (Eastern and Western Europe, Central Asia, North Africa and North America), Equatorial cane (Asia, Africa, North, Central and South America), Southern hemisphere cane, Oceania (Australia and Fiji), Southern Africa and South America (Brazil and Argentina).

In most countries, sugar production is concentrated over three to five-month campaigns timed to take advantage of maximum sugar content. This characteristic creates a strong seasonality in sugar output, availability and exports can lead to world price volatility during the year (Hannah and Spence, 1996). Northern hemisphere beets are harvested largely within a three-month period from October to December; equatorial cane is processed mainly from November to April; and southern hemisphere cane from May to December. Consequently, from November to April world stocks of sugar build up rapidly and in a surplus year this can exert downward pressure on prices. Conversely, after April stocks begin to decline, reaching their lowest point in August or September, and this can cause seasonal price rises in a normal year and rapid increases in prices in a deficit year (Hannah and Spence, 1996).

In Table 1-1 (at the end of Chapter 1) data is presented on major sugar producing countries. The top ten sugar producers in 1980 accounted for 56.3% of world production. Their contribution to world sugar has continued to grow over the 30-year period starting in 1980, with the same countries accounting for about 73.7% of world production as of 2010 (FAS, USDA, 2011). Production statistics indicate that total world production grew by 80% between 1980 and 2010 from 84.6 million metric tons (MMT) to 152.2 MMT. Among top-10 producers Thailand's production grew six fold (532%), while for Pakistan 2010 production statistics are 5.6 times those of 1980. Brazil, the biggest sugar producer by volume, multiplied its production fivefold, while China and India are the other two countries that posted significant production gains of 361% and 276% respectively. Production in the EU grew by 22%, while Cuba was the only top-10 country to have production decline. It declined by 85% over the 30-year time period.

With respect to consumption (Table 1-2), India tops the list with six million metric tons of sugar consumed in 1980, compared to 23.5 million in 2010, a growth rate of 252% over the 30- year period. The other main consumers are the European Union (a 50.5% growth rate over the same time period), China (302.7%) and Brazil (93.5%). This is not surprising given that these are the most populous countries in the world. Consumption declined in the United States (-3%), Japan (-26.6%) and Russia (-26.8%). It is unclear why sugar consumption fell over the past 30 years in these three countries, although the prevalence of high fructose corn syrup, a competitor especially in the US market, could be the reason. To summarize, the top-10 countries' sugar consumption increased by 110.9% while global sugar consumption rose by 63.4% in the period 1980 to 2010.

About a third of the world sugar produced is traded and this figure has been stable for the past 30-years, as shown in Table 1-3. What has not been stable though is the growth rate in exports for some countries. Brazilian sugar exports grew tenfold between 1980 and 2010 followed by Guatemala and Thailand that grew nine fold. Colombia was the other country to post significant growth in exports, two and half times in 2010 what they were in 1980. The EU (-55.2%), Cuba (-92.6%) and India (-97.9%) posted the largest percentage declines in exports. Despite sugar being produced in over 120 countries, ten of them account for about 80% of traded sugar in 2010 compared to 67.3% traded in 1980.

The level of domination in sugar imports is less pronounced than for exports (Table 1-4). Russia imports most sugar in the world followed by the EU, the United States, Indonesia and South Korea, comprising the top five. The European Union, despite being a sugar importer, also is a significant player in sugar exports, highlighting the unique footprint it has on world sugar markets. The majority of sugar shipped to the EU is imported under a special import quota referred to as preferential sugar based on the Cotonou Agreement that allows for sugar from some ACP nations and India to enter the European markets at zero duty (Schmitz, 2002).

A significant number of developing countries are sugar producers, and they rely on the crop to boost their foreign currency reserves. The African, Caribbean and Pacific (ACP) group of countries is one such cohort. It is dominated by Southern African nations, with Swaziland producing most sugar, followed by Mauritius and Zimbabwe, with Kenya and Fiji completing the top five (Table 1-5). Despite their high degree of efficiency in production, sugar quantities are still relatively small and have historically been between 2.9% and 4.4% of world production over the past 30 years. Not all African countries are in the ACP. South Africa is the dominant producer in the African continent having accounted for 40% of African production in the early 1980's and currently produces about a quarter of the African output. Production in Africa tends to be highly susceptible to weather changes, for example, output in South Africa fell by 30% in 1983 due to drought conditions (Abbot, 1990).

EU Sugar Policy and International Commitments

Co-operation between the European Union (at that time, the European Economic Community) and African, Caribbean and Pacific nations started in 1957 with the signing of the Treaty of Rome, which gave life to the European Common Market (EU website, 2012). The Treaty of Rome provided for the creation of European Development Funds (EDFs) whose aim was providing technical and financial assistance to colonies and countries that had historical ties to members of the community. The Lome Convention established how the European Community would co-operate with 77 ACP countries. Lome I of 1975 defined the non-reciprocal nature of preferences for most of the ACP countries to the European Economic Community (EEC). Under Lome I, a system (STABEX) was introduced to compensate ACP countries for shortfalls in export earnings due to fluctuations in prices or supply for commodities concerned. Beyond that Lome II was signed in 1979 and mostly dealt with the mining industry. Lome III was signed in 1984 as a 10-year agreement, shifting focus to promotion of industrial development meant to promote self-sufficiency and food security. Lome IV focused on the promotion of human rights, democracy and good governance, strengthening of the position of women in society, protection of the environment, diversification of ACP countries, promotion of the private sector and increasing regional co-operation.

Trade in sugar between ACP Sugar producers and the EU was prior to the reform, which came into effect in 2006, based on the following agreements (a) the EU/ACP Sugar Protocol as annexed in the Cotonou Agreement, (b) the agreement on Special Preferential Sugar (SPS Agreement) and (c) the Everything But Arms Initiative (EBA) (Serrano, 2007).

Sugar protocol

It is documented (Serrano, 2007) that the Sugar Protocol opened the Community market to 1.6 million tons of cane-sugar from 18 ACP countries, discriminating against countries which were not signatories. The agreement was first introduced in 1975 as part of the Lome I agreement and was continued through successive Lome agreements. With the expiration of the Lome IV agreement, the Sugar Protocol was then annexed into the Cotonou Agreement of 2000. Article 1 of the EU/ACP Sugar Protocol emphasizes that the three pillars of the protocol were agreed quantities, guaranteed prices and indefinite duration. The Sugar Protocol states that “the Community undertakes for an indefinite period to purchase and import at guaranteed prices, specific quantities of cane sugar, raw or white, which originates in the ACP states and which these states undertake to deliver it”.

Article 3(2) of the EU/ACP Sugar Protocol emphasizes that subject to Article 7, these quantities may not be reduced without the consent of the individual countries involved. Guaranteed prices are negotiated annually and refer to bulk sugar cost of insurance plus freight (CIF) to EU ports. Prices have in practice, tended to be the same as those received by community sugar producers.

The “agreed quantities” listed in Table 1-6 indicate what each country was to supply the EU upon joining the ACP Sugar Protocol. Article 7 states that, if during any delivery period, a sugar exporting ACP state fails to deliver its agreed quantity in full for reasons of force majeure the Commission shall, at the request of the state concerned allow for necessary additional period for delivery. If this failed, then that quantity could be reduced in respect of each subsequent delivery period by the undelivered quantity. It could also be decided that the undelivered quantity be reallocated among the other states.

SPS agreement

When Portugal and Spain joined the EU in 1986, the ACP formulated a request to supply the raw sugar deficit of Portuguese sugar refineries, and in August 1992, the Commission drafted a proposal for a regulation on supplies to the Portuguese sugar refineries[1]. This agreement first brought to light the idea of maximum supply needs (MSNs), for the Community's refineries (Serrano, 2007). It also introduced the idea of a hierarchy of preference from domestic suppliers, to ACP under the Protocol, and lastly third country suppliers, for example, Cuba and Brazil, who would be allowed to export to the EU with no preferences.

The SPS agreement with ACP states was reached in June 1995, like the ACP/EU Sugar Protocol, it is a government-to-government agreement, but unlike the Protocol, it ran for a fixed duration and the ACP states were jointly liable to supply the quantities of sugar covered by the SPS agreement. The main aspect of the SPS Agreement was the concept of maximum supply needs, established with reference to

[1] Sourced from http://www.acpsugar.org/old/protocols.htm#GuaranteedPrices

the EU refineries. So imports varied as per need for a particular year, thus in 1995/96 imports were 344,000 tons while in 2002/03 imports amounted to 217,000 tons (Serrano, 2007).

Everything but Arms initiative

There has generally been consensus that least developed countries (LDCs) should receive more favorable treatment in market access than other developing countries. This has led to a gradual liberalization of market access for products from these countries (Gotor and Tsigas, 2006). An EU trade website[2] reports that a United Nations Conference on Trade and Development (UNCTAD) in 1968 recommended the creation of a Generalized System Tariff Preferences (GSP) under which industrialized countries would grant autonomous trade preferences to all developing countries. A waiver was granted in 1971 from Article 1 of the GATT, which prohibits discrimination, to authorize developed countries to establish individual Generalized Schemes of Tariff Preferences. The first EU GSP scheme was implemented in 1971 but in order to update its scheme on a regular basis and to adjust it to the changing environment of the multilateral trading system, the EU's GSP is implemented following ten year cycles.

In February 2001, the Council adopted Regulation (EC) 416/2001, the so-called Everything But Arms Regulation (EBA), granting duty-free access to imports of all products from LDCs, except arms and ammunition, without any quantitative restrictions (with the exception of bananas, sugar and rice for a limited period). In doing so, the EU extended free access to all agricultural products, doing away with tariffs. Provisions were made for free access for rice and sugar through a process of progressive tariff

[2] http://ec.europa.eu/trade/wider-agenda/development/generalised-system-of-preferences/everything-but-arms/

elimination starting in 2006, and which were to result in full liberalization in 2009. This agreement extended duty and quota free access to all products originating in LDCs, except for arms and ammunition (Gotor and Tsigas, 2006).

In an EU Council Regulation[3] 416/2001 it is documented that at the Singapore ministerial conference in December 1996, member countries of the World Trade Organization (WTO) pledged to carry out an action plan to improve access to their markets for products originating in the least developed countries. It is further documented in the same regulation that in June 1997 the Council agreed on a platform calling for the Singapore conclusions to be implemented by granting least developed countries not party to the Lomé Convention preferences equivalent to those enjoyed by signatories and, in the medium term, duty free access for essentially all least developed country products.

When this initiative was adopted, it immediately extended duty and quota free access to a wide array of commodities including meat, dairy, fruits, vegetables, cereals, processed sugar and cocoa containing products and alcoholic beverages. For fresh bananas, EU tariffs were to be gradually reduced to zero by the beginning of 2006. At the beginning of July 2001 and for the eight years that followed, the EU Commission opened duty free quotas for raw cane sugar for refining, initially amounting to 74185 tons white sugar equivalent and increasing by 15 per cent in each subsequent July to June marketing year and were pegged at 197335 MT in the 2008/09 marketing year. Tariffs on sugar from the LDC's under the EBA have since been abolished, and therefore sugar from these countries now enters duty free. Sugar from 18 ACP

[3] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2001:060:0043:0050:EN:PDF

countries also is duty free. By granting duty free and quota free access to the EU market, it was expected that these countries would considerably expand their exports to the EU, with the commission estimating that imports could reach as high as three million tons a year (Bureau et al., 2008).

The Pre-Reform EU Sugar Situation

Pre-reform, the general philosophy and principles underlying the organization and marketing of sugar in the community was the creation of a single market among members free of obstacles; creation of a common set of regulations, superseding national regulations, governing the production and marketing of both beet and cane sugar; ensuring that production was based on a quota system; creation of a system of guaranteed minimum prices covering the basic quotas allocated to producers and planters; ensuring that producers shared in the cost of disposing of surplus exports; ensuring that isoglucose (HFCS), a competitive product was integrated into the organization of the market; and that imports were accommodated under a special system for African, Caribbean, and Pacific (ACP) sugar (Abbot, 1990). These principles evolved over time, mainly in response to political pressure, the original policy objectives, however, remain intact, and the EU is self-sufficient in sugar without the accumulation of growing surpluses, stabilizing production in those regions which are not well suited to growing beet sugar, increasing production efficiency in those regions which are, and keeping the cost of the sugar regime within manageable proportions.

Sugar beet production in the EU is controlled by the imposition of country specific quotas which apply to white sugar, the final product, and thus have the effect of constraining farm level output. The CMO’s provisions identified a basic quota, the present ‘A’ quota, corresponding to community consumption and split among member states on the basis of previous production. In addition to the basic quota granted, each enterprise could produce an additional quantity set at between 30% and 45% of the basic quota, according to market disposal potential. The basic quota and its supplement formed the maximum quota for each enterprise. The supplement evolved to become the present 'B' quota (EC report, 2004; Abbot, 1990). While 'A' quota guaranteed each member state a share of the community market, 'B' quota added some flexibility and allowed for changes that could occur due to the unpredictable nature of agricultural production. 'A' and 'B' quotas can both be sold on the EU market or exported, for which they are eligible for export subsidies. 'C' sugar refers to any sugar produced in excess of the maximum quota from 'A' and 'B' combined. It cannot be sold in the home market, but must be exported to third country markets at the producer's risk. 'C' sugar production which was almost non-existent in the early years of the CMO, has risen steadily with productivity gains exceeding 2.6 million tons or 20% of production under quota. When added to exportable sugar of the 'A' and 'B' quotas (1 million tons) and exports of a quantity equivalent to the ACP and India preferential imports (1.6 million tons), 'C' sugar had made the European Union the main player on the world white sugar market, with average exports of around five million tons (EC Report, 2004).

The principles of the EU sugar market regime are illustrated in Figure 1-1, and are adapted from the work of Frandsen et al. (2003) and Milner et al. (2004). The production of 'A' sugar is paid a guaranteed price P_A, and production of 'B' sugar is paid the price P_B, while 'C' sugar produced is paid the prevailing world price P_w. The prices of 'A' and 'B' sugar are linked to the intervention price (P_I) by charging 'A' sugar produced a 2% levy, while 'B' sugar is levied a maximum of 37.5% (Milner et al., 2004). Domestic consumption is given by the intersection of the demand curve (D) and the intervention price P_I. Excess production is exported to the world market at the price P_w, with the costs of exports equal to $c + d$ covered by export refunds financed by levies on 'A' and 'B' production equivalent to $(a + b + c)$.

The Pressure to Reform

For more than four decades, sugar trade in the EU had been regulated by the Common Market Organization (CMO) which was established in 1968 and whose main goal was ensuring self-sufficiency in the EU market (Abbot, 1990). What evolved over time though was a costly supply management scheme for the EU domestic sugar market which insulated domestic producers from international competition by means of a system of price supports and prohibitive import tariffs (South Center, 2007). There is evidence from sugar price data (World Bank, 2011) that the policies that were followed by the EU over time resulted in domestic prices three times higher than world free market prices as well as production surpluses were exported to the world markets using expensive market distorting subsidies. Part of the supply management scheme involved granting duty free access for certain amounts of sugar from the African, Caribbean and Pacific countries (ACP), a block made up of mostly former British and French colonies. Many economists (Marks and Muskus, 1993; Borrell and Pearce, 1999) believe that the sugar protocol which allows 18 ACP countries preferential access to the EU has allowed high cost producers to stay in business despite lack of competitiveness.

Australia, Brazil and Thailand, all countries which did not have access to the protected EU market, filed a complaint, in September 2002, against the EU claiming that the volume of the EU's subsidized exports of sugar exceeded the levels the EU had committed itself under the Uruguay Round Agreements (Milner et al., 2004). One of the main issues of the complaint was about 1.6 million tons of sugar that originates from the ACP and India that the EU re-exported to the world markets at subsidized rates. A World Trade Organization (WTO) panel and the Appellate body ruled in favor of the three complainants, finding that the EU exceeded its subsidy commitments. The EU was then obliged to bring its domestic market regulation into conformity with its WTO obligations (South Center, 2007). The increasing costs of the Common Agricultural Policy (CAP) have also contributed to internal pressure to reform, while the expansion of the EU has made it necessary to revisit some of these agreements including the Sugar Protocol.

To be compliant with WTO regulations, in 2005 the European Agricultural Council agreed to a set of reforms to the EU sugar sector that were to result in an eventual 36% price cut, with beet growers compensated with direct income payments. In addition, they agreed on a quota buy back scheme, funded by those processors staying in the sugar sector, to compensate processors leaving the sector. The envisaged net result of reform was that by 2011, EU sugar production would be reduced by between 25% and 33% from roughly 20 million metric tons white sugar in 2005 to a figure between 13 and 15 million metric tons. The reforms were expected to leave the EU sugar price at roughly double the world market prices compared to 2005 prices when it was three times world prices (Gain Report E35225, 2005). Other features essential to the proposed reform include phasing out of sugar intervention; eliminating over-quota sugar exports; elimination of re-exports of sugar imported under preferential terms.

The price reductions, however, contradict the interests of the ACP beneficiaries of the Sugar Protocol, since the guaranteed price under the protocol has traditionally resembled the EU domestic price. In other words, ACP farmers under the agreement get paid at price levels that prevail in the EU, therefore lowering EU prices affects ACP farmers negatively. The South Center (2007) reports that the EU sugar market reform yielded even more consequences for the signatories of the Sugar Protocol, providing for the termination of preferences by October 2009. In September 2007, the EU denounced the sugar protocol, for two reasons, providing for the termination of preferences by October 2009. First, EU policy makers wanted to take pressure off the over-supplied domestic market which had proven to be relatively resistant to initial reforms. The elimination of guaranteed imports hence would complement efforts to reduce domestic over supply. Second, there was increasing doubt whether the sugar protocol, if upheld for indefinite duration, would withstand legal challenges under WTO law, mostly because the Sugar Protocol preferences generally violate non-discrimination obligations contained in the GATT 1994 (South Center, 2007). The EU had received a waiver which, expired in 2007, which allowed it to grant trade preferences under the Cotonou Agreement, of which the Sugar Protocol is an integral part. By 2008, the preferences were highly vulnerable to legal challenge from other WTO members. By denouncing the protocol, the EU was eliminating the possibility of further WTO complaints that could have been laid against it as early as 2008, the year after the waiver expired.

Reforms to the EU Sugar Policy

According to Council Regulation (EC) No 318/2006 of February 20th 2006, the basic features of the proposal were that:

- Sugar price be reduced by 36 percent from €631.9 to €404.4 per metric ton (mt) over a 4-year phase-in period beginning in 2006/07.
- Minimum sugar beet price is reduced by 39.5 percent to €26.3/mt over the phase-in period.
- Sugar production quotas are not reduced except through a voluntary 4-year restructuring program where quota can be sold and retired. Payments for quota are €730/mt for 2006/07 and 2007/08; €625/mt for 2008/09 and €520/mt for 2009/10.
- Restructuring is financed by quota levies on producers and processors who do not sell quota. Total value of the restructuring fund is projected at €5.704 billion.
- Compensation is available to farmers at an average of 64.2 percent of the price cut. The aid is included in the Single Farm Payment and is linked to payments for compliance with environmental and land management standards.
- Establishment of a prohibitive super levy to be applied to over-quota production.

The Research Problem

ACP countries and the LDCs under the Everything but Arms agreements are about to lose rural income (agricultural production and export revenues, rural labor income) as the EU is further reforming its sugar policy. The loss of guaranteed high sugar prices could exacerbate rural poverty in ACP (and LDC) countries. The issue is then to investigate how to compensate them or what policies could be put in place to mitigate these potential losses. Attempting to evaluate the effects of policy changes that have global effects can be challenging. By its very nature, the Sugar Protocol provides an alternative marketing channel for sugar exporting ACP countries. For an average ACP country a share of 40% of domestic production and 62% of the sugar exports are covered by the sugar quota, i.e. how much they are allowed to export into the EU, and the quota can be sold on the EU market guaranteed EU prices. This basic point leads to a revenue raising impact in typical years, and in medium run to revenue stabilizing effect (Roland and Dietmar, 1995). It is thus unclear at this point how an EU policy change would affect production in ACP countries and what the implications for the rest of the world are. Given that these countries have different sugar production efficiencies, some might benefit and others lose, the question is by how much.

It is possible that if full liberalization were to occur in the EU sugar sector, the EU would cease to be a sugar producer especially of sugar beets, leading to a rise in the world sugar price. Because ACP farmers are currently paid prices that are two to three times higher than the world sugar price, abolishing the sugar protocol would probably lead to a welfare loss in ACP countries. The extent of the welfare loss is however unknown. There is therefore a need to understand the economic effects of EU reforms, while they are still in their early stages of implementation, in order to better inform policy making in the European Union, ACP countries and the rest of the sugar producing and trading nations.

Overall Aim and Individual Research Objectives

Given that most ACP countries have agriculturally based economies, any agricultural sector that guarantees the economy a steady influx of foreign exchange is critical and needs to be cultivated. In parts of the world where poverty and unemployment are endemic, the welfare of farmers is a development problem. People's livelihoods can be traced back to the farm. Thus understanding the possible trickle down effects of a policy changes made in Europe is important if poor countries are to win the war on poverty, and get on a path towards sustainable economic growth. Agriculture is also a significant employer in many of these countries, therefore understanding the potential effects of CAP policy changes on poor ACP farmers could help fill the void in literature related to liberalization of sugar markets which has tended to focus more on what happens in North America and Europe, with little to no coverage of Sub-Saharan Africa. The study intends to build a world sugar trade model to understand the effects of EU sugar policy reform on world production and how it would affect sugar production in the ACP countries and the rest of the world, and what the effects of reforms are on world sugar prices.

This study occurs in steps that initially that require a world sugar trade model be built to address the different scenarios that have arisen and need to be understood. Specifically what needs to be understood is the following:

a. What are the effects of EU sugar policy reform on world production? How will this affect sugar production in the ACP countries and the rest of the world? Related to this is understanding what the effects of reforms are on world sugar prices.

b. What are the welfare benefits, if any, of the EU sugar reforms on ACP countries and the rest of the world?

Outline of the Study

In addition to the opening (Chapter 1), the study has an additional four chapters that cover literature review (Chapter 2), methodology (Chapter 3), results (Chapter 4) and conclusions (Chapter 5). Literature review summarizes studies on the impacts of liberalization on sugar markets with specific emphasis on the global as well as ACP focus. The objective of a literature review, however, is to summarize and synthesize the arguments and ideas of others as a foundation of the arguments put forward in this dissertation. The methodology chapter lays out the theoretical basis of the models used, while the results and conclusion chapters will complete the dissertation.

Table 1-1. Major sugar producers (1980 to 2010) in (‘000) MT

Producing Country	1980	1990	2000	2005	2006	2007	2008	2009	2010
Brazil	7,027	7,793	20,100	28,175	26,850	31,450	31,600	31,850	36,400
India	5,170	12,575	20,219	14,170	21,140	30,780	28,630	15,960	19,460
EU	13,646	16,944	19,498	21,648	21,373	17,757	15,614	14,014	16,683
China	2,507	5,618	6,947	9,826	9,446	12,855	15,898	13,317	11,566
United States	5,205	6,070	8,194	7,146	6,713	7,662	7,396	6,833	7,118
Thailand	1,098	3,502	5,721	5,187	4,835	6,720	7,820	7,200	6,940
Mexico	2,763	3,605	4,979	6,149	5,604	5,633	5,852	5,260	4,900
Australia	2,963	3,797	5,448	5,388	5,297	5,212	4,939	4,814	4,700
Pakistan	609	1,987	2,595	2,937	2,597	3,615	4,163	3,512	3,420
Cuba	6,670	8,000	4,060	1,350	1,240	1,200	1,420	1,250	1,000
Top-10	47,658	69,891	97,761	101,976	105,095	122,884	123,332	104,010	112,187
World Total Production (WTP)	84,626	109,967	135,722	140,674	144,550	164,196	163,087	143,540	152,188
Top-10 as % of WTP	56.3	63.6	72.0	72.5	72.7	74.8	75.6	72.5	73.7

Source: Author’s own calculations using USDA data

Table 1-2. Major sugar consumers (1980 to 2010) in (‘000) MT

Consuming Country	1980	1990	2000	2005	2006	2007	2008	2009	2010
India	6,667	11,535	17,296	20,385	19,870	22,425	23,500	24,200	23,500
EU	11,166	13,921	14,512	17,505	16,800	19,816	16,496	16,754	16,800
China	3,700	7,450	8,476	11,400	11,500	13,500	14,250	14,500	14,900
Brazil	6,098	6,800	9,100	10,600	10,630	10,800	11,400	11,650	11,800
United States	9,665	7,836	9,040	9,089	9,239	8,993	9,590	9,501	9,344
Russia	-	7,600	6,130	6,300	5,400	5,950	5,990	5,990	5,560
Mexico	3,125	4,038	4,445	5,199	5,406	5,133	4,728	5,065	4,600
Pakistan	818	2,270	3,300	3,750	3,850	3,950	4,100	4,175	4,200
Indonesia	1,739	2,340	3,200	3,550	3,850	4,300	4,400	4,500	4,400
Japan	3,268	2,827	2,142	2,238	2,220	2,300	2,350	2,375	2,400
Top-10	46,246	66,617	77,641	90,016	88,765	97,167	96,804	98,710	97,504
World Total Consumption (WTC)	91,035	106,824	127,372	142,396	141,824	150,411	151,413	153,504	153,265
Top-10 as % of WTC	50.8	62.4	61.0	63.2	62.6	64.6	63.9	64.3	63.6

Source: Author’s own calculations using USDA data

Table 1-3. Major sugar exporters (1980 to 2010) in ('000) MT

Exporting Country	1980	1990	2000	2005	2006	2007	2008	2009	2010
Brazil	2,333	1,500	11,300	18,020	17,090	20,850	19,500	21,550	24,300
EU	4,909	6,575	6,138	6,028	8,345	2,439	1,656	1,331	2,200
Thailand	569	2,611	4,147	3,115	2,242	4,705	4,914	5,295	5,000
Australia	2,318	2,927	4,123	4,447	4,208	3,860	3,700	3,522	3,600
Cuba	6,583	7,065	3,400	770	730	705	800	725	490
Guatemala	180	502	1,140	1,386	1,391	1,500	1,333	1,654	1,654
United Arab Emirates	0	0	850	1,600	1,665	1,600	1,715	1,725	1,750
South Africa	966	927	1,410	1,010	1,230	1,267	1,154	1,185	870
India	243	32	25	40	1,510	2,680	5,830	176	5
Colombia	288	426	959	1,231	988	942	661	585	730
Top-10	18,389	22,565	33,492	37,647	39,399	40,548	41,263	37,748	40,599
World Total Exports (WTE)	27,306	34,140	41,770	46,930	49,864	51,439	51,535	48,860	50,518
Top-10 as a % of WTE	67.3	66.1	80.2	80.2	79.0	78.8	80.1	77.3	80.4

Source: Author's own calculations using USDA data

Table 1-4. Major sugar importers (2000 to 2010) in ('000) MT

Importing Country	2000	2005	2006	2007	2008	2009	2010
Russia	5,170	4,300	2,900	2,950	3,100	3,100	2,110
EU	1,786	2,549	2,630	3,530	2,948	3,173	3,450
United States	1,484	1,905	3,124	1,887	2,377	2,796	2,286
Indonesia	1,949	1,450	1,800	1,800	2,420	2,197	2,600
South Korea	1,514	1,652	1,669	1,518	1,648	1,550	1,600
United Arab Emirates	925	1,756	1,730	1,605	1,890	1,930	1,905
Japan	1,650	1,328	1,385	1,405	1,440	1,452	1,416
Malaysia	1,256	1,459	1,414	1,670	1,390	1,430	1,520
Canada	1,207	1,274	1,445	1,294	1,417	1,350	1,300
Saudi Arabia	765	1,155	1,260	1,280	1,625	1,575	1,350
Top-10	17,706	18,828	19,357	18,939	20,255	20,553	19,537
World Total Imports (WTI)	37,023	45,418	44,757	43,504	45,377	48,169	51,298
Top-10 as a % of WTI	47.8	41.5	43.2	43.5	44.6	42.7	38.1

Source: Author's own calculations using USDA data

Table 1-5. Sugar production in the ACP nations (1980 to 2010) in ('000) MT

Country Name	1980	1990	1995	2000	2005	2006	2007	2008	2009	2010
Swaziland	254	504	495	550	598	653	634	653	650	658
Mauritius	730	602	532	396	580	550	535	460	480	505
Zimbabwe	314	502	524	583	525	445	436	350	297	259
Kenya	401	441	302	471	489	476	476	518	530	550
Fiji	473	461	535	392	330	275	230	230	190	200
Guyana	310	130	254	325	250	260	265	230	240	300
Malawi	113	175	210	225	215	220	275	310	330	330
Zambia	111	142	155	197	250	260	215	240	390	480
Tanzania	119	95	105	125	255	260	260	285	280	290
Jamaica	251	229	212	216	124	147	164	160	170	130
Uganda	5	30	75	130	200	195	200	240	290	320
Cote d'Ivoire	103	164	150	179	140	145	145	143	150	155
Belize	105	99	104	118	105	120	105	85	100	115
DR Congo	51	60	70	73	75	75	75	75	70	85
Madagascar	117	120	140	77	26	20	15	15	25	25
Trinidad and Tobago	114	121	90	115	35	25	33	0	0	0
Barbados	132	69	40	58	40	35	35	35	35	35
St. Kitts and Nevis	36	25	20	18	15	0	0	0	0	0
Suriname	12	1	1	1	1	0	1	1	1	1
ACP Sugar Total	3,751	3,970	4,014	4,249	4,253	4,161	4,099	4,030	4,228	4,438
% of World Total	4.4	3.6	3.4	3.1	3	2.9	2.5	2.5	2.9	2.9

Source: Author's own calculations using USDA data

Table 1-6. ACP plus India export deliverables per marketing year (MT)

ACP Country	1975	2003/04
Belize	39,400	40,394
Congo (Brazzaville)	10,000	10,186
Cote d'Ivoire	--	10,186
Fiji	163,600	165,348
Guyana	157,700	159,410
Jamaica	118,300	118,696
Kenya	5,000	0
Barbados	49,300	50,312
Madagascar	10,000	10,760
Malawi	20,000	20,824
Mauritius	487,200	491,031
Uganda	5,000	0
St. Kitts and Nevis	14,800	15,591
Surinam	4,000	0
Swaziland	116,000	117,845
Tanzania	10,000	10,186
Trinidad and Tobago	69,000	43,751
Zambia	--	0
Zimbabwe	--	30,225
India	25,000	10,000
Total	1,304,300	1,304,745

Source: EC Report (2004)

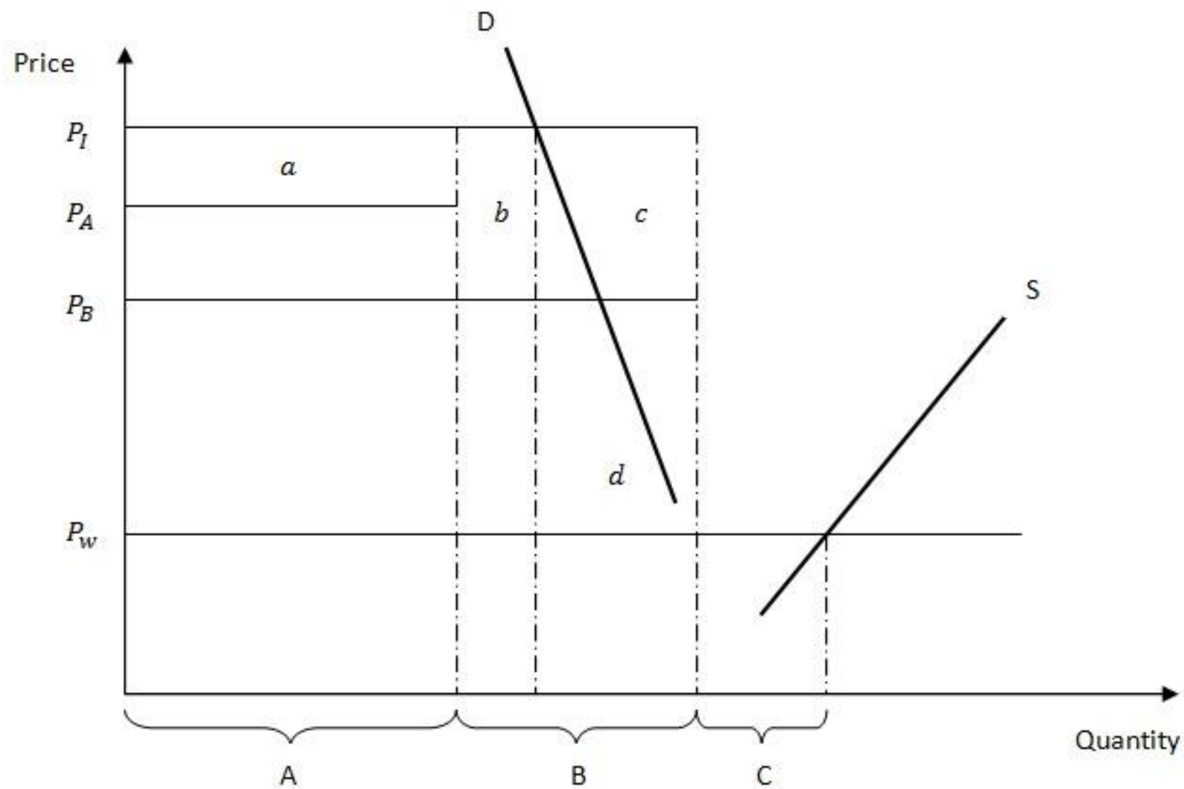

Figure 1-1. EU sugar scheme pre-reform

CHAPTER 2
LITERATURE REVIEW

Many studies have attempted to measure the gains in either industrial market economies or all world economies resulting from liberalizing trade of agricultural commodities. Because the major actors in this liberalization tend to be developed countries, much of the modeling effort has been focused on the effects of agricultural trade liberalization of developed country economies and whatever spill-over effects there might be to developing economies. Developing countries are usually considered in these models as passive actors who follow the dictates of an international trading system. Agricultural policies in developing countries are complex and tend to serve many goals from tax revenue collection, income redistribution, securing political support or food security issues (Hammer and Knudsen, 1990).

The purpose of this chapter is a review of the literature on trade and its significance in the global economy, with an emphasis on the liberalization of sugar markets and an interest in understanding models of trade in sugar that have been developed over time with applications to the EU-ACP Sugar Protocol.

The Benefits of Trade

In general there is agreement in the economics literature that gains from opening up economies to trade tend to outweigh gains from implementing protectionist policies. Dornbusch presented the case for trade liberalization in his 1992 paper. Before giving an account of the case for liberalization, and why it is beneficial to developing countries, Dornbusch presented a short history of protection dating back to the Great Depression. In the 1930s a number of industrialized countries adopted restrictive trade policies and manipulated commodity prices to the disadvantage of developing countries that primarily exported commodities and used them as a source of foreign exchange. It appears the developed world did this hoping that developing producing nations would eventually face declining terms of trade.

Post World War II, the developed world moved towards market liberalization while developing countries, especially in Latin America, pursued the policy of import substitution, i.e., developing local industries while protecting them from outside competition using tariffs, quotas and import licenses. In the late 1960s and 70s many countries recognized that protection using tariffs and quotas did keep imports out, but that the resulting decline in demand for foreign exchange led to the appreciation of the domestic currency, and hence a severe tax on exports of both traditional commodities and emerging industrial goods. So because of the harm in exports that can be caused by unstable exchange rates, studies show that countries that adopted outward oriented policies, or those that at least neutralized anti export bias, performed better than countries who failed to understand and act on the adverse effects of restrictions on exports.

Four main points are laid out in Dornbusch (1992) referred to as the gains to trade. First consumers are huge gainers because, post trade, their incomes can now buy more commodities, resources are used more efficiently, since they no longer have to produce goods that can be imported at a lower price. Trade liberalization increases the variety of goods available in a market. It also raises productivity, by providing less expensive or higher quality intermediate goods. The argument is that in a restricted economy, only a narrow range of goods can be profitably produced and therefore a full range of technological possibilities, which rely on a potentially broader range of inputs, cannot be exploited effectively. Instead access to a variety of foreign inputs at a lower cost shifts the economy wide production function outward, leading to higher national output and more goods being available for trade.

Also free trade according to Dornbusch, leads to a more economically rational market structure. Gains from liberalization can result from scale economies and economies of scope that must rise in wider markets. Markets in protected economies are narrow and lack competitors from the rest of the world, and this has a tendency of fostering inefficiencies like oligopoly. Market structure can be different under free trade because protectionism can create market power for domestic firms that they otherwise would not have if the competition was much stronger.

Dollar and Kraay (2004) hypothesized on what could happen when developing countries liberalize trade and participate more in the global trading system. That is, if growth rates were to accelerate as a result of the moving from a closed to open economies, how income and equity issues would be impacted. They suggest that one of the best ways for less developed countries to proportionately raise poor people’s incomes and thus alleviate poverty is through opening up their markets to global competition. Their methodology identifies countries that opened up to globalization post 1980 based on their growth in trade relative to GDP in constant prices and based on their reduction in average tariff rates. Because of the unavailability of tariff data prior to 1985, the authors use tariff reduction data for the period 1985-89 to the period 1995-97, and trade volume data from 1975-79 to 1995-97.

To understand the experiences of globalizers, Dollar and Kraay compare this group to rich and non-globalizing (closed) developing countries, reporting simple average and population weighted average of trade volumes, tariffs and growth. The paper reports substantial increases in integration in the world economy among globalizers where the trade to GDP ratio went from 16% to 33% of GDP, while it grew from 29% to 50% of GDP for rich countries but trade actually fell as a share of GDP 60% to 49% for non-globalizers. By comparing the rich, the globalizers and the non-globalizers their results suggest that trade openness leads to declining inequality between countries, and declining poverty within countries. Poor countries who participated more in international trade saw their growth rates accelerate which in turn lead to income growth domestically, while developing countries with closed economies fell behind. They also emphasize that per capita growth rates increased among the globalizing economies in the 1990s relative to the 1980s, ranging between 5% and 10% in successful economies, while growth in the rest of the developing world was stuck below 1%. Lastly concerning the consequences of rapid growth among globalizers on income equality across individuals they note that in the 1990s economies that opened up in the developing world grew faster than rich countries, creating an important trend toward equality among open economies.

Work by Chenery et al. (1986) suggests that periods of trade liberalization also tend to be periods where total factor productivity is unusually high. Trade is seen as Schumpeterian, creative destructionist, in the sense that taking bold moves that rid of barriers can promote a new growth environment. Such a discontinuity can involve introduction of a new good, introduction of a new method of production; the opening of new markets; the conquest of a new source of supply of raw materials and the carrying out of the new organization of any industry.

Anderson et al. (2006) considered how agricultural markets and value added would change, if over the decade that began in 2005 and ended in 2015, all merchandise trade barriers and agricultural subsidies were simultaneously removed. The analysis tool used is a World Bank model called LINKAGE, in collaboration with Global Trade Analysis Project database (GTAP). LINKAGE is a computable general equilibrium model (CGE), which differs from other static CGE models in that it is recursive, and can be solved annually. According to Anderson et al. (2006), governments are the main distorters of market equilibrium primarily with border measures. By intervening in markets for foreign exchange, governments affect the price of tradeables relative to non-tradeables while quantitative trade restrictions like quotas have the power to influence the relative prices of various tradeables. Anderson et al. (2006) argue that phasing out import taxes, and converting many non-tariff trade barriers to tariffs over the years, has made measuring the extent of distortions to goods markets much easier because attention can focus on import tariffs and agricultural subsidies.

The main gist of the paper was to understand how each region of the world welfare, agricultural markets, and farm incomes would change if all trade distortions were removed completely. The LINKAGE model accounted for key global multilateral commitments in its pre-simulation, namely the final stages of the Uruguay Round, phasing out of the Multifibre Arrangement (MFA) and the accession of China and Taiwan to the WTO, and the enlargement of the European Union (EU) from fifteen to twenty five nations. According to the LINKAGE model, removal of all trade barriers would lead to global gains of $287 billion per year by 2015. The biggest beneficiaries would be high income countries who would net two thirds of the $287 billion, however as a share of national income, developing countries would gain more, with an average increase of 0.8% compared to 0.6% for high income countries.

When decomposed by sector the results indicate that a worldwide move to liberalize agriculture and food markets would contribute 63% of the total worldwide gains, even though the share of agriculture in global GDP was 4% while merchandise trade contributes 9%. So basically liberalization would enhance trade while global value of output would remain unchanged. Therefore the global share of agricultural food and production exported rises from 9.5% to 13.2% which translates to $192 billion in increase in exports to developing countries. Even though Latin American countries would gain the most, low income countries would sell an extra $36 billion worth of goods per year, or a 52% increase. Numerous middle to high income countries are projected to lose farm jobs in the model, between the 2005 and 2015 period. For the most protected farm sectors the rate of farm employment decline would more than double if the world were to move to completely free trade, requiring more members of farm households to seek off farm employment.

Turning to specific agricultural commodities, rice and sugar are especially noteworthy. Their global shares of production exported treble. Developing countries share of global output especially output rises, in the case sugar, from 62% in the baseline to 80% under full liberalization. Cotton is a product that is important to several countries in sub-Saharan Africa and South America (Brazil), and yet it is also produced under high subsidy in the United States. LINKAGE predicts that under full liberalization, the value of cotton production would drop by a third or $5 billion mostly in the USA and the value of exports would decline by $3.6 billion. World totals would not change as the slack would be picked up by developing countries. The benefits from increased production would account $1.1 billion in net income for sub-Saharan African countries and cotton exports of $1.9 billion per year in the absence of trade barriers and subsidies. This is equivalent to about a quarter in net gain in agricultural value added in sub-Saharan Africa from full liberalization.

The results also support the notion that returns to unskilled labor rise substantially in developing countries, and by more than wages of skilled workers which implies that full reform would likely improve equity and reduce poverty in developing countries given that the vast majority of poor earn income as unskilled workers. The bottom line, therefore, is that according to the latest GTAP database and the LINKAGE model, developing country agricultural production, employment, and real net income would increase by 2015 if all current distortions to world trade merchandise were phased out.

Sugar Trade Models

World sugar trade models have been around for decades to answer questions that have been relevant at different times. Bates and Schmitz (1969) developed a spatial equilibrium model to understand the long-run price and trade effects of the United States 1960 embargo on Cuban sugar. Among the objectives of the model were estimation of the cost of transporting sugar using ocean-going vessels, ascertain optimal trade patterns, predict prices and trade flows and calculate the long-run price and trade effects of the US embargo on Cuban sugar.

Gemmill (1976) described a world sugar economy using econometric techniques to understand production and modeling different policy scenarios. The purpose of this study was to estimate supply and demand functions for sugar for each of the major producing and consuming nations of the world, and use these functions to develop a model that would allow for the understanding of impacts of different policies. The model was conceived in both static and dynamic forms to give solutions both in long-run equilibrium and in an annual, recursive mode. Gemmill (1976) utilized a spatial equilibrium model of the Samuelson (1952) type but rather than using quadratic programming it used "reactive programming" developed by Tramel and Seale, because he found that is was much easier to adapt to a variety of trade policies than quadratic programming.

Recently, Poonyth et al. (2000) evaluated the impact of the World Trade Organization (WTO) restrictions (Uruguay Round agreement) on the EU sugar sector and the world sugar market. Using a non-spatial static equilibrium model, they find that complete elimination of export subsidies by 2005 would require either a 10% reduction in production or the combination of 8% reduction in quotas and an 11% reduction in intervention prices. This emphasizes the point that the world market impacts of reductions in subsidized EU sugar exports depend on the manner in which those reductions are achieved. Relying on quota reductions alone results in smaller reductions in total EU exports than if the intervention prices are reduced. They also find that higher world prices resulting from reduced EU exports would result in increased production of unsubsidized C-sugar, the type of sugar that cannot be sold within the EU, and thus has to be exported.

Koo (2002) analyzed the impacts of alternative trade liberalization policies in the United States and European Union (EU) on the US sugar industry applying a model developed by Benirschka et al. (1996) which consisted of 17 sugar consuming and producing nations. The Benirschka et al. (1996) econometric model estimates sugar production, consumption and carry-over stock equations for all countries using time series data. Area and yield equations are used to determine supply. Area harvested is modeled as a function of lagged area, prices of sugar and alternative crops and government policies. Supply is given as product of area harvested and yield per hectare, while consumption is modeled on a per capita basis with price of sugar, income and time trend as the explanatory variables. Total consumption is computed by taking the product of per capita consumption and the population of the country. In Koo (2002) the market equilibrium condition requires that the sum of all country's excess demand be zero, resulting with the aggregate excess demand equation solved for the equilibrium price.

Three scenarios are considered by Koo (2002). In the first, US eliminates its TRQ and loan rates on sugar for 2001 to 2004, while other countries maintain their subsidies and import restricting programs. The results were that the world price of sugar would go up 32% in 2004 because increased US sugar imports raise demand for sugar in the world market. US wholesale prices would decrease 20.4% because imports increase US sugar supply. Sugar beet production would decline by 16.2% while sugar cane production would also decline by 11.1% in 2004, while consumption increases 5.5% in the same year.

In the second scenario, the EU eliminates its import restrictions and subsidies on sugar for 2001 to 2004, while other countries maintain their subsidies and import restricting programs. The result of this according to Koo (2002) would be an increase in the world price by 21.6% in 2004. The US wholesale price of refined sugar would increase by 6.5% mainly because the US restricts imports to stabilize price of sugar. US sugar cane and beet production increase, while consumption decreases. The third scenario had both the US and EU eliminating import restrictions and subsidies for 2001 and 2004, while other countries maintain subsidies and import restricting programs. Under this scenario, the world price of sugar would increase by 68.2% from 9.68 cents per pound to 16.28 cents per pound in 2004 because the EU would have become a net importer, and so does the US, and as they both increased their imports global prices would increases due to increased global demand. US wholesale prices would respond by decreasing 4.7% while sugar beet and sugarcane production went down by 7.2% and 3.3% respectively. Consumption in the US would increase slightly by 2.1%.

Elobeid and Beghin (2006) analyzed the impact of trade liberalization, removal of production subsidies and elimination of consumption distortions in world markets using a partial equilibrium international sugar model calibrated on 2002 market data and 2006 policies. Their model referred to as CARD[1], is a non-spatial, partial equilibrium econometric world model consisting of 29 countries / regions with a rest-of-the-world aggregate to close off the model. The characteristics of countries in the CARD model is that they are major sugar-producing, exporting and importing countries for which only raw sugar production use and trade is specified. The model does not disaggregate raw sugar trade from refined sugar trade. Elobeid and Beghin (2006) chose not to model the ACP explicitly because of the consensus view that ACP countries would not be able to export sugar to the EU were it not for the EU's high guaranteed price.

[1] Center for Agricultural and Rural Development, Iowa State University.

Individual country sub models include behavioral equations for area harvested, yield, production of sugarcane and sugar beets on the supply side, and per capita consumption and ending stocks on the demand side. Equilibrium prices, quantities and net trade are determined by equating excess supply and excess demand across countries and regions. The Elobeid and Beghin (2006) paper considers three scenarios, the first of which starts with the removal of trade distortions affecting the sugar markets which are mostly tariffs, exports taxes/subsidies, tariff rate quotas (TRQs) and state trading. The second scenario considers the further removal of domestic production policies in addition to the trade liberalization of the first scenario, while the third set considers the additional removal of consumption distortions, which are the least frequent, along with previous reforms considered under scenarios one and two.

The removal of trade distortions increases the world sugar price by 27% in the year 2011/12 while aggregate trade increases by a moderate 4% in the same year. Elobeid and Beghin (2006) found that in OECD countries where sugar producers are also protected by domestic policies, removal of trade distortions has a small impact, even though consumption increases as sugar users face the world sugar price. By implementing the second scenario, a 48% price increase is induced in 2011/12 causing aggregate world sugar production and use to decrease by about 3% on average. Under this scenario, major sugar production relocation would take place away from highly protected OECD markets towards competitive producers in moderately protected developing countries chiefly Brazil and Cuba and to moderately protected OECD countries mostly Australia. The third scenario is full market liberalization, and it tended to be felt mostly within countries implementing the reform and less on a global scale.

Nolte et al. (2011) states in their paper that the current Common Market Organization (CMO) for sugar is expiring in the year 2014/15 and that there is a possibility that quotas in sugar production and marketing might be abolished. If this scenario were to happen, they confer that producers within the EU would still be protected by tariffs, however they foresee increased competition between EU and member states and re-allocation of sugar production to more competitive regions possibly discouraging future imports from the ACP, LDC and other nations. The paper uses a Takayama and Judge (1971) type spatial equilibrium model to analyze how the abolition of sugar quotas after 2014/15 would impact production, prices and EU imports.

According to Nolte et al. (2011) the spatial equilibrium framework, even though an adequate model for this type of analysis, is known to perform poorly in reproducing trade matrices. To overcome this problem they calibrate the model by attaching a non-linear costs term to each trade flow. Their model is formulated as a mixed complementarity problem, which means that their problem does not have an objective function to be optimized.

In their critique of the spatial equilibrium framework Nolte et al. (2011) state that such models behave like tools for normative analysis despite the fact that optimization in economics is a tool for positive economic analysis. The linear programming formulation is restricted to $2n - 1$ trade flows where n is the number of exporting and importing regions, thus the trade flow restriction does not allow the replication of observed trade patterns of products that show trade flows that exceed the number of constraints. According to them the model does not allow for cross hauling. Further on, they state that because of the failure of the spatial equilibrium framework to account fully for observed trade patterns, they adopt a hypothesis of non-constant and non-uniform transaction costs which allows them to attach a non-linear cost term to each trade flow.

One of the main results of Nolte et al. (2011) is that under all world market price scenarios, the abolition of the quota lead to an increase in production in the EU and correspondingly to a decrease in preferential imports. The higher the world market prices, the more pronounced was this tendency. Their model predicts that if the world market prices were sufficiently high, preferential imports were entirely displaced and the EU turns to exporting to the world market again.

Effects of Trade Policies on the ACP-EU Sugar Protocol

On September 28, 2007 the Council of the European Union issued a press statement terminating the sugar protocol (ACP-EC Cotonou partnership agreement) also ceasing imports from India under the same agreement with effect from October 1 2009. This agreement had since 1975 enabled certain African, Caribbean and Pacific (ACP) states and India the ability to supply sugar to the EU market on preferential terms. This was to be replaced by a policy adopted in 2001, but taking effect in 2009, which would allow the world's least developed countries (LDC's) to supply "everything but arms" to the EU market, completely free of tariffs or quota restrictions. In July 2006 the reforms were implemented, starting with 36% reduction of the guaranteed price for EU producers. Also being negotiated were Economic Partnership Agreements (EPAs) with ACP states which was intended to create conditions for ACPs to use trade as a tool for development, allowing them to access the EU markets with terms similar to those afforded the LDC's.

Anticipating these changes considerable research was done to understand the impacts of these reforms. Herrmann and Weiss (1995), in their paper ‘A Welfare Analysis of the EC-ACP Sugar Protocol’, point out that despite the well known principle of development theory that financial aid can be better targeted to indicators of development then trade tied aid, however there seems to be wide agreement between the ‘donor’ and ‘recipient’ countries the Sugar Protocol laid down at the Lome Convention worked well. According to them, the Sugar Protocol could be seen as an international commodity policy since it affected prices, trade and hence, export earnings and economic welfare. As Article 1 of the protocol states that the EU imports ‘at guaranteed prices, specific quantities of cane sugar, raw or white, which originate from the ACP states and which these countries undertake to deliver it’. In this way the Sugar Protocol affects prices, trade, and export earnings and economics welfare of sugar exporting ACP countries.

To provide an economic evaluation of the performance of the Sugar Protocol over the period 1975-91 Herrmann and Weiss (1995) distinguish between two kinds of economic benefits

- the transfer benefit, which is defined here as the welfare gain arising from a higher sugar export price under the sugar protocol compared with a hypothetical non-protocol situation;
- the risk benefit, which is a welfare gain for the risk averse planners in the sugar exporting countries arising from the stabilizing impact of the sugar protocol on export earnings.

The total welfare gain as a consequence of a policy is defined as the sum of the transfer and risk benefit (Herrmann and Weiss, 1995) where the transfer benefit is the increase in income due to a policy and the risk benefit captures the welfare change which is attributed to a change in the income risk following a policy. They argue that sugar export revenues (R) and the instability of sugar export revenues (I^R) enter the welfare function of a user country of the sugar protocol to give a national welfare function $W = W(R, I^R)$ where the impact of a policy instrument on a national welfare can be calculated as

$$\frac{\Delta W}{W} = \frac{\Delta \mathrm{R}}{R} - 0.5\rho * \Delta V_R^2 \qquad (2\text{-}1)$$

where ρ is the coefficient of relative risk aversion and V_R^2 is the coefficient of variation of I^R. The first term on the RHS of Equation 2-1 is the welfare change in national export earnings as a consequence of the protocol. This is the protocol's transfer benefit. The second term on the RHS captures the national benefits from reducing costly fluctuations of export earnings. It is the risk benefit of the Sugar Protocol.

Herrmann and Weiss (1995) concluded that during 1975 to 1991 total sugar export earnings for all countries amounted to 14.4 billion ECU[2] compared to 10.9 billion ECU if the protocol was non-existent. The 3.5 billion ECU was the accumulated transfer benefit due to the Sugar Protocol and was interpreted as the welfare gain for the ACP countries plus India. Sugar export earnings of user countries had been increased by 32% in preferential situation compared to the non-preferential scenario. Without the protocol Herrmann and Weiss (1995) found that instability of sugar export earnings ranged from 36.5% for Suriname to 241.6% for Kenya. With the exception of Suriname, the study found that Mauritius had a 70.6% reduction in instability, Jamaica followed with a 69.5% reduction, Trinidad and Tobago 67% and the export revenues of other countries are stabilized by 30% or more. Only Zimbabwe, Kenya and India had

[2] The European Currency Unit was a basket of the currencies of the European Community member states, used as the unit of account of the European Community before being replaced by the euro on 1 January 1999, at parity. The ECU itself replaced the European Unit of Account, also at parity, on 13 March 1979.

stabilization effects below 10% mainly because of their relatively low share of sugar exports to the EU. The median stabilization impact of the Sugar Protocol across user countries, excluding Suriname, amounted to 33.6%, i.e., reducing instability in many countries by more than a third.

Borrell and Hubbard (2000) quantified the cost of EU protection and suggest that to quantify the effects of the Common Agricultural Policy (CAP) on the EU and the rest of the world requires imagining how the economies of many nations would change if the CAP on sugar were to be abolished, replacing it with free trade. To measure the aggregate effects of the CAP they adopted and modified the Global Trade Analysis Project (GTAP) database and standard model developed by Hertel (1997). To simulate what would happen if the CAP were abolished, EU barriers to trade and direct subsidies were eliminated from the model. This serves to remove all the CAP support to EU farmers and lowers the prices they receive and EU consumers pay. The model then simulates how EU producers and consumers would respond to such changes. Borell and Hubbard (2000) found that the effects of the CAP were that, firstly, it was the largest source of distorting subsidies. Specifically producers of over 40% of world production receive prices that are 50% to nearly 400% higher than the world price. But on a value basis, it is the subsidies in the EU that are largest. Quota restricted access to the EU market provided export subsidies of $560 million a year to over 20 countries, with Mauritius being the biggest recipient with nearly $200 million in subsidies a year. Secondly, world prices would rise up to 38% with trade liberalization. Their model predicted a fall in prices by around 65% in Japan, 40% in Western Europe, and 25% in the United States, Mexico, Indonesia and Eastern Europe. Lower prices in these countries would induce increases in consumption and decrease in production of sugar, which would raise import demand and increase world prices by 30% to 38%. In response, efficient low-cost producers would increase production.

While it has been argued that the liberalization of agricultural trade offers potentially large benefits for developing countries [e.g. Dornbusch (1992), Dollar and Kraay (2004), Anderson and Tyers (1991)], there are a substantial number of developing countries which may lose out, namely those that currently enjoy preferential trading arrangements, either bilateral or multilateral, with developed countries (McDonald, 1996). During the period 1975-92 gross income transfers are estimated to have been worth US$4.45billion at 1987 prices, or, on average 0.69% of GDP in ACP countries. There are, however, substantial variations across countries in magnitude and relative importance of quota rents. For Belize, Fiji, Guyana, Mauritius, St Kitts and Swaziland they represent a large proportion of GDP and would undoubtedly suffer from substantial reduction in quota rents. With reforms estimates for the year 2000 indicated appreciable reduction in income transfers. The ACP countries as a whole suffer a loss of some US$123million (at 1987 prices) in trading revenues. Most of the income is borne by Caribbean countries, nearly US$41million, and Fiji and Mauritius nearly US$62million. The relatively small populations in these countries mean the losses will occur in those ACP countries least able to diversify and those most dependent in sugar for foreign exchange earnings.

Given the pressure that the World Trade Organization (WTO) exerted on the EU, Milner et al. (2004) explored different ways in which reform could affect the transfer of welfare to ACP countries. They concluded that the importance of transfers for each of the protocol countries would depend on the size and degree of diversification of the country's exports. For example as shown in Table 2-1, for some countries it is important (almost 10%) in Barbados, Belize, Fiji and Swaziland, and yet extremely important (greater than 10%) for Guyana and Mauritius. The transfer per capita figures show a very marked variation depending on the allocation of the transfers across countries and on the size of countries in population terms. For some countries the transfer are negligible (less than $1/person) and yet in some countries they are substantial being over $50 per person as in Swaziland, Fiji, Belize and Guyana, and in the case of Mauritius, it is equivalent to $150 per capita.

A review of literature on the impact of the EU Sugar Policy Reforms on the world sugar market yields mixed results. Most studies appear to show that liberalization would in general lead to the EU becoming a net sugar importer, and with a probable shifting of production to countries with lower production costs. What is not clear is the extent of the impact on welfare and prices. All studies are in agreement though that no matter how small the prices changes are, they are at least all positive. To carry out and understand the present effects of the sugar reforms on ACP countries, this research will have to establish what the transfers as a result of the protocol were for each of the participating countries in the years prior to the reforms and afterwards, with the differences used as part of the indicators of the policy impacts.

Table 2-1. Current income transfer relative to various indicators (%)

	Transfer as a percentage of Total sugar exports	Total exports	Value of sugar production at world prices	Value of sugar production at EU prices	GDP	Transfer per capita ($)
Barbados	59.4	7.1	169.6	64.0	0.6	60.2
Belize	43.5	8.9	68.4	25.8	1.9	59.9
Congo, Rep	6.7	0.0	7.7	2.9	0.0	0.2
Cote d'Ivoire	24.9	0.1	11.1	4.2	0.0	0.2
Fiji	48.8	8.6	78.3	29.6	2.9	59.2
Guyana	53.6	12.7	112.4	42.4	8.7	79.4
Jamaica	58.1	3.8	118.8	44.8	0.6	17.2
Kenya	59.3	0.1	1.7	0.6	0.0	0.0
Madagascar	51.8	0.5	51.7	19.5	0.1	0.3
Malawi	45.4	3.9	31.3	11.8	0.7	1.2
Mauritius	57.2	11.9	138.6	52.3	4.0	150.6
St Kitts and Nevis	--	--	0.0	0.0	--	--
Suriname	--	0.0	0.0	0.0	--	--
Swaziland	35.4	7.0	52.2	19.7	4.3	51.3
Tanzania	59.6	0.6	20.4	7.7	0.0	0.1
Trinidad and Tobago	53.4	0.3	86.3	32.6	0.2	11.3
Uganda		0.0	0.0	0.0	--	--
Zambia	15.8	0.6	12.6	4.8	0.1	0.5
Zimbabwe	26.3	1.1	19.1	7.2	0.2	1.6
Protocol Total	47.3	2.1	61.5	23.2	0.6	3.0

Source: Milner et al. (2004)

CHAPTER 3
METHODOLOGY

The methodology section develops the mathematical programming model in the spatial equilibrium framework that is the basis of the sugar trade model.

The Spatial Equilibrium Model

Takayama and Judge (1971) developed a spatial price equilibrium model, building on the work of Cournot (1838), Enke (1951) and Samuelson (1952), where prices, production, consumption and geographical flows for a single commodity are determined, when linear functions are acceptable approximations to the regional demand and supply functions. Let i, j denote the geographical regions which compose the discrete but divisible production and consumption locations, where $i, j = 1, 2, \ldots n$. We assume that each country has both production and consumption regions. There are transportation costs involved, since the countries are separated physically, let these unit costs be expressed as $t_{ij} \geq 0$ for all i and j. Let us assume that for each country, demand and supply quantities are given by the following linear functions of price:

$$P_{di} = f_i(Q_{di}) = \propto_i - \beta_i Q_{di} \tag{3-1}$$

where Q_{di} is the quantity demanded in the i^{th} region and P_{di} is the demand price in the i^{th} region and $\lambda_i > 0$ and $w_i > 0$; and

$$P_{si} = f_i(Q_{si}) = v_i + \eta_i Q_{si} \tag{3-2}$$

where Q_{si} is the quantity shipped in the i^{th} region and P_{si} is the supply price in the i^{th} region and $\eta_i > 0$. For each region, assume that the quantity actually consumed Q_{di} is less than or equal to the quantity shipped into the region from all the supply regions. Thus, $Q_{di} \leq \sum_{j=1}^{n} x_{ji}$ where $x_{ji} \geq 0$ for all i and j and is the quantity shipped from the j^{th}

region to the i^{th} region. The actual supply quantity Q_{si} is assumed to be greater than or equal to the effective supply from region i to all regions, meaning that the quantity shipped between the regions is less than the supply available, i.e., $Q_{si} \geq \sum_{j=1}^{n} x_{ij}$ where $x_{ij} \geq 0$ for all i and j. Given this framework, the objective is to develop a mathematical programming model which yields a competitive spatial equilibrium price and allocation solution.

A simple welfare function that only accounts for producer and consumer surplus can be specified as follows

$$W_i(Q_{di}^*, Q_{si}^*) = \int_0^{Q_{di}^*} P_{di} dQ_{di} - \int_0^{Q_{si}^*} P_{si} dQ_{si} \tag{3-3}$$

which in the case of linear demand equations, the problem can be re-specified explicitly as

$$W_i(Q_{di}^*, Q_{si}^*) = \int_0^{Q_{di}^*} (\alpha_i - \beta_i Q_{di}) dQ_{di} - \int_0^{Q_{si}^*} (v_i + \eta_i Q_{si}) dQ_{si} \tag{3-4}$$

and the right hand side can be further simplified into Equation 3-5 which gives a quadratic programming problem.

$$= \left[\alpha_i Q_{di} - \frac{1}{2}\beta_i Q_{di}^2\right]_0^{Q_{di}^*} - \left[v_i Q_{si} + \frac{1}{2}\eta_i Q_{si}^2\right]_0^{Q_{si}^*} \tag{3-5}$$

The Takayama and Judge model (1971) allows for modifications to be made to accommodate government action. Consider that the importing country or regions through legislation levy import tariffs and exporting countries or regions imposed export subsidies. We represent the cost of transporting a unit of good x from i to j by t_{ij} and a tariff imposed by the j^{th} country or region on a commodity from the i^{th} country or region by π_{ij}. We represent a subsidy paid by the i^{th} country or region to her own exporters by, exporting the commodity to the j^{th} importing country or region by σ_{ij}. Since subsidies are paid to only to the exported part of total supply, while tariffs are imposed on quantity actually imported, the social cost to the consumer is

$$\sum_{i=1}^{n}\sum_{j=1}^{n}\left(t_{ij}+\pi_{ij}-\sigma_{ij}\right)x_{ij} \tag{3-6}$$

We can set up an optimization problem with Net Welfare (NW) as the objective function, with supply and demand balance constraints. Specifically the supply and demand balance constraints require that

(a) Outgoing shipments from region[1] i do not exceed total world supply

$$Q_{si} \geq \textstyle\sum_j x_{ij} \text{ for all } i \tag{3-7}$$

(b) Incoming shipments into region[2] j do not exceed total world supply

$$Q_{dj} \leq \textstyle\sum_i x_{ij} \text{ for all } j \tag{3-8}$$

Given the demand and supply equations, we can setup an optimization problem with net welfare (NW) as the objective function, with supply and demand balance constraints. The problem can be presented as follows

$$\text{Max NW} = \textstyle\sum_j \int_0^{Q^*_{dj}} P_{dj} dQ_{dj} - \sum_i \int_0^{Q^*_{si}} P_{si} dQ_{si} - \sum_{i=1}^{I}\sum_{j=1}^{J}\left(t_{ij}+\pi_{ij}-\sigma_{ij}\right)x_{ij} \tag{3-9}$$

subject to

(i) $Q_{dj} - \sum_j x_{ji} \leq 0$ for all i

[1] Note that terms country and region are used interchangeably in this model.

[2] Also note that i is the supply region, while j is the demand region.

(ii) $-Q_{si} + \sum_j x_{ij} \leq 0$ for all i

(iii) $Q_{dj},\ Q_{si}, x_{ij} \geq 0$ for all i and j

The nature of the solution to this problem can be understood by investigating parts of the Kuhn-Tucker conditions. By taking the first order conditions, that is differentiating the Lagrangian with respect to Q_{dj}, Q_{si}, and x_{ij}. Let the Lagrangian of the problem be expressed as follows

$$L(\Phi) = NW + \sum_j \lambda_{dj}\left(\sum_i x_{ij} - Q_{dj}\right) + \sum_i \lambda_{si}\left(Q_{si} - \sum_j x_{ij}\right) \quad (3\text{-}10)$$

where $\Phi = (Q_{di}, Q_{si}, x_{ij})$, then the derived first order conditions are

(i) $\frac{\partial L}{\partial Q_{dj}} = \propto_j - \beta_j Q_{dj} - \lambda_{dj} \leq 0, \quad \left(\frac{\partial L}{\partial Q_{dj}}\right)(Q_{dj}) = 0, \quad Q_{dj} \geq 0$

(ii) $\frac{\partial L}{\partial Q_{si}} = -v_i - \eta_i Q_{si} + \lambda_{si} \leq 0, \quad \left(\frac{\partial L}{\partial Q_{si}}\right)(Q_{si}) = 0, \quad Q_{si} \geq 0$

(iii) $\frac{\partial L}{\partial x_{ij}} = -t_{ij} - \pi_{ij} + \sigma_{ij} + \lambda_{dj} - \lambda_{si} \leq 0, \quad \left(\frac{\partial L}{\partial x_{ij}}\right)(x_{ij}) = 0, \ x_{ij} \geq 0$

The first order conditions imply that the shadow price in region j (λ_{dj}) equals the demand price in that region if Q_{dj} is positive. Similarly λ_{si} equals the supply price in that region if Q_{si} is positive. Since $P_{dj} = \propto_j - \beta_j Q_{dj}$ and $P_{si} = v_i + \eta_i Q_{si}$ this implies that $P_{dj} = \lambda_{dj}$ and $P_{si} = \lambda_{si}$. From equation (3.1.10c) we can substitute P_{dj} and P_{si} for shadow prices λ_{dj} and λ_{si} to get $-T_{ij} + P_{dj} - P_{si} \leq 0$, where $T_{ij} = t_{ij} + \pi_{ij} - \sigma_{ij}$ is to be referred to as the 'net tariff' associated with x_{ij}. This can be re-arranged such that

$$P_{dj} \leq P_{si} + T_{ij} \quad (3\text{-}11)$$

This means that the demand price in region j is less than or equal to the supply price in region i plus the net tariff of shipping from region i to j. A distinguishing characteristic of a spatial price equilibrium problem is that the objective of the researcher is to compute supply and demand prices, and determine trade flows satisfying the equilibrium condition that the demand price is equal to the supply price plus the cost of transportation if there is trade between the pair of supply and demand markets. If the demand price is less than the supply price plus the transportation cost, then there will be no trade.

Some countries impose an ad valorem tariff on imports such that exporters face a price $\widetilde{\mathrm{P}}_{\mathrm{j}} = \frac{\mathrm{P_j}}{1+\mathrm{AD_j}}$, where AD_j is the ad valorem tariff imposed by region *j*. Note that when $AD_j = 0$ then $\tilde{P} = P_j$. This implies that the net welfare function, Equation 3-9 can be modified to

$$\mathrm{NW} = \sum_{\mathrm{j}} \left(\frac{1}{1+\mathrm{AD_j}}\right) \int_0^{\mathrm{Q_{dj}^*}} \mathrm{P_{dj}} \mathrm{dQ_{dj}} - \sum_{\mathrm{i}} \int_0^{\mathrm{Q_{si}^*}} \mathrm{P_{si}} \mathrm{dQ_{si}} - \sum_{\mathrm{i}=1}^{\mathrm{n}} \sum_{\mathrm{j}=1}^{\mathrm{n}} \left(\mathrm{t_{ij}} + \mathrm{\pi_{ij}} - \mathrm{\sigma_{ij}}\right) \mathrm{x_{ij}} \qquad (3\text{-}12)$$

Even though sugar is produced from sugar beets and cane, the final product is assumed to be homogeneous. The outputs of the model are (a) the net price in each region or country, (b) the quantity of exports and imports for each region or country (c) which regions export, import or do neither, and (d) the volume and direction of trade between a pair of countries.

Modeling the Price Floor in the EU

Thore (1986) extended the spatial equilibrium model by Takayama and Judge (1971) to deal with the case of disequilibrium caused by rigid prices and / or price controls. He extends his approach to the spatial equilibrium model and shows that it can be solved by mathematical programming approaches. As in Takayama and Judge (1971), let us consider a single good traded in several geographical regions, $i =$

$1,2,\ldots,I$. The demand for the good in region i is written Q_{di} and let the demand price function P_{di} be positive, differentiable and decreasing on $Q_{di} \geq 0$. The supply in region i is written Q_{si} and let the supply price function P_{si} be positive, differentiable and increasing on $Q_{si} \geq 0$. We can then define the contribution to "social payoff" in region i as

$$\mathrm{f}(\mathrm{Q_{di}}, \mathrm{Q_{si}}) = \int \mathrm{P_{di}}\,\mathrm{dQ_{di}} - \int \mathrm{P_{si}}\,\mathrm{dQ_{si}} \tag{3-13}$$

which is a concave function. Let x_{ij} denote the quantity transported from region i to j. Unit transport costs are T_{ij}. Thore (1986) then forms a mathematical programming problem

$$\mathrm{Max}\ \sum \mathrm{f}(\mathrm{Q_{di}}, \mathrm{Q_{si}}) - \sum\sum \mathrm{T_{ij}x_{ij}} \tag{3-14}$$

subject to

(i) $\mathrm{Q_{di}} - \mathrm{Q_{si}} - \sum\left(\mathrm{x_{ij}} - \mathrm{x_{ji}}\right) \leq 0$ for $\mathrm{Q_{di}}, \mathrm{Q_{si}} \geq 0$

Unlike in the Takayama and Judge (1971) model the Thore (1986) combines the demand and supply balance constraints into a single constraint, which states that sugar demand in each region cannot exceed the local supply and net shipments into and out of the region. Following the work of Thore (1986), let us now assume that the price is rigid

$$\overline{\mathrm{P}}_{\mathrm{fi}} \leq \mathrm{P_i^*} \leq \overline{\mathrm{P}}_{\mathrm{ci}} \tag{3-15}$$

where $\overline{\mathrm{P}}_{\mathrm{fi}}$ and $\overline{\mathrm{P}}_{\mathrm{ci}}$ are the price floor and price ceiling in the region i, respectively. In order to handle the case of disequilibrium, the following concave programming model is proposed

$$\mathrm{Max}\ \sum[\mathrm{f}(\mathrm{Q_{di}}, \mathrm{Q_{si}}) + \overline{\mathrm{P}}_{\mathrm{fi}}\mathrm{U_i} - \overline{\mathrm{P}}_{\mathrm{ci}}\mathrm{V_i}] - \sum\sum \mathrm{T_{ij}x_{ij}} \tag{3-16}$$

subject to

(i) $\mathrm{Q_{di}} - \mathrm{Q_{si}} - \sum_{\mathrm{j}}\left(\mathrm{x_{ij}} - \mathrm{x_{ji}}\right) + \mathrm{U_i} - \mathrm{V_i} = 0$ for $(\mathrm{i} = 1, \ldots, \mathrm{I})$ and

$Q_{di}, Q_{si}, t, u, v \geq 0$

The sum of the first three terms on the left hand side of Equation 3-16 denotes demand minus supply in region i, after accounting for inter-regional trade. Note further that the optimal solution to Equation 3-16 must satisfy $(U_i)(V_i) = 0$, that both these cannot both be positive at the same time, because if that were the case, it would be possible to increase the value optimal solution by subtracting some positive constant from both of them. Hence according to Thore (1986) U_i denotes a possible excess supply in region i, and V_i denotes a possible excess demand in region i where we can mathematically represent these two as $Q_{dj} = \sum_i x_{ij} + V_j$ and $Q_{si} = \sum_j x_{ij} + U_i$ which means (for the later equation) that excess supply (U_i) in region i is the difference between what is supplied in region i and all the other sugar that is brought in from different j regions.

Ignoring the price ceiling, since there are none in the world sugar trade model, the Lagrangian for this problem can be set up as follows

$$L(\phi) = \sum_j \left[\alpha_j Q_{dj} - \frac{1}{2}\beta_j Q_{dj}^2 + \overline{P}_{fj} U_j\right] + \sum_i \left[v_i Q_{si} + \frac{1}{2}\eta_i Q_{si}^2\right] - \sum_i \sum_j T_{ij} x_{ij} + \sum_i \lambda_i \left[0 - Q_{di} + Q_{si} + \sum_i (x_{ij} - x_{ji}) - U_i\right] \tag{3-17}$$

where $\phi = (Q_{dj}, Q_{si}, x_{ij}, U_i)$, then the first order conditions derived are defined as follows

(i) $\frac{\partial L}{\partial Q_{dj}} = \alpha_j - \beta_j Q_{dj} - \lambda_j \leq 0, \quad \left(\frac{\partial L}{\partial Q_{di}}\right)(Q_{di}) = 0, \quad Q_{di} \geq 0$

(ii) $\frac{\partial L}{\partial Q_{si}} = -v_i - \eta_i Q_{si} + \lambda_i \leq 0, \quad \left(\frac{\partial L}{\partial Q_{si}}\right)(Q_{si}) = 0, \quad Q_{si} \geq 0$

(iii) $\frac{\partial L}{\partial x_{ij}} = -T_{ij} + \lambda_j - \lambda_i \leq 0, \quad \left(\frac{\partial L}{\partial x_{ij}}\right)(x_{ij}) = 0, \quad x_{ij} \geq 0$

(iv) $\frac{\partial L}{\partial U_i} = \overline{P}_{fi} - \lambda_i \leq 0, \quad \left(\frac{\partial L}{\partial U}\right)(U_i) = 0, \quad U_i \geq 0$

As in the Takayama and Judge (1971) model, from the first order conditions we find that equilibrium prices P_{dj}^* and P_{si}^* are equivalent to the shadow prices. There is now, however an additional condition to be considered which is used to model policy intervention in the form of price control. Adding a price floor, Equation 3-17, results in the condition that $\bar{P}_{fi} - \lambda_i \leq 0$ but $\lambda_i = P_{si}$, so $\bar{P}_{fi} \leq P_{si}$. The equilibrium solution from this model therefore allows us to accommodate the fact that the EU has as one of its price intervention policies, a price floor. This model allows for any country that produces sugar to impose a price floor, however since only the EU has such a pricing policy in this model, the price floor vector is denoted by

$$\bar{\mathbf{P}}_{\mathbf{f}} \begin{cases} = 0 \text{ if i} \neq \text{EU} \\ \geq 0 \text{ if i} = \text{EU} \end{cases} \tag{3-18}$$

which only allows the EU price floor to enter the objective function of the quadratic programming model, thereby accounting for one of the significant policies responsible for maintaining EU sugar prices two to three times above the Caribbean world price.

Having developed the theoretical framework for the model, the next step is the estimation of parameters for demand, supply and transportation cost equations that are necessary to build a mathematical programming model.

CHAPTER 4
EMPIRICAL ESTIMATION

The main intention of this research is to quantify the extent of the losses that could be suffered by poor countries that previously had guaranteed access to the EU market, but now face uncertainties as a result of a new set of policies adopted by the EU. To understand the impact of the change in EU policies, the main sugar producing and consuming countries in the world are incorporated into the model. To reach this objective, a world sugar trade model is developed to determine the direction of flows of sugar from production to consumption regions, and to determine equilibrium prices. The process involves estimating domestic supply and demand equations for all countries in the model. The demand and supply elasticities and transport costs are then used to set up a baseline model which computes net social welfare, defined as the sum of producer and consumer surplus less transportation costs, using 2009 as the base year. The social welfare function is optimized using the Generalized Algebraic Modeling System (GAMS), a mathematical programming language. This chapter explains the steps followed in estimating the demand and supply equations and the transportation costs.

Estimation of Demand Elasticities

The application of econometrics to the theory of demand requires, in addition to data, a specification of an econometric model. For a consumer, demand functions can be generalized for n goods as

$$x_j = x_j(p_1, p_2, \ldots, p_j, \ldots, p_n, I), \quad j = 1,2 \ldots, n. \tag{4-1}$$

The n equations indicate the quantity demanded of each of the goods as a function of all prices (P_i) and income (I) (Intriligator, 1978). Econometric studies of demand include both single demand equations and systems of demand equations. In the case of a single demand equation, the idea is to select one equation from Equation 4-1, and estimate its parameters such that if the first equation is taken, for example, and a stochastic term, u_1 added to account for omitted variables, misspecification, and errors in measuring variables. A single demand equation study would estimate

$$x_1 = x_1(p_1, p_2, \dots, p_n, I, u_1), \quad j = 1,2 \dots, n. \tag{4-2}$$

In this study a single demand equation for sugar for each of the countries in the model is estimated. In order to estimate a single demand equation a variety of functional forms have been utilized and perhaps the simplest functional form is the linear one, which can be written as

$$x_1 = a_1 + b_1p_1 + b_2p_2 + \cdots + b_np_n + c_1I + u_1 \tag{4-3}$$

where the prices $p_1, p_2, \dots, p_n$ and income I are treated as exogenous explanatory variables (Intriligator, 1978). Given an estimated linear demand, Equation 4-3, the implied elasticity of demand, evaluated at the mean value of price and quantity is given by

$$\in = \frac{\partial x_1}{\partial p_1}\frac{\bar{p}_1}{\bar{x}_1} = b_1\frac{\bar{p}_1}{\bar{x}_1} \tag{4-4}$$

where $\bar{p}_1$ and $\bar{x}_1$ are mean values.

Gemmill (1980) examined the demand for sugar using pooled data from 73 nations and estimated flexible functional forms for demand equations. In that paper, the quantity of sugar consumed per capita, Q, in the i^{th} country in the t^{th} year may be expected to be a function of own price at retail price P, per capita income Y, prices of subsititutes PS, and tastes W, thus specifying:

$$Q_{it} = f(P_{it}, Y_{it}, PS_{it}, W_{it}) \tag{4-5}$$

The Gemmill (1980) study however then drops the price of substitutes from the specification because the main substitutes to sugar, sweeteners and High Fructose

Corn Syrup (HFCS), tend to be collinearly related to sugar and are only of importance to a few countries such as the United States. Substitution between sugar and other carbohydrates was found to be unimportant by Viton and Pignalosa (1961). That paper finds that pooled international data on sugar suggests that the more complicated forms of specification may not be much superior to the simple semi-logarithmic[1] form. It therefore appears that the simplest procedure for estimating demand elasticities consistent with economic theory is to estimate $Q = f(P, Y)$ where Q is the per capita quantity of sugar demanded, P is the wholesale price of sugar relative to other goods, and Y is the income variables usually measured by per capita Gross Domestic Product.

The focus is that the single equation demand model be appropriate, where an appropriate model is defined as one which generates unbiased (or at least consistent) and efficient parameter estimates (Thursby and Thursby, 1984). Simple sugar demand equations were estimated following the form presented in Equation 4-3. Consumption at time t (C_t) was the dependent variable, with three explanatory variables, price, income measures by per capita Gross Domestic Product, and a time trend variable.

$$C_t = \propto_0 + \propto_1 P_t + \propto_2 GDP_t + \propto_3 t \tag{4-6}$$

Results for the estimation for the individual countries are listed in the first column of Table 4-1 and are also compared to elasticities found from other studies. There is a huge variation in elasticity estimates from running Equation (4-6) and what other studies report as shown in Table 4-1. To understand why price estimates for agricultural supply response differ, Askari and Cummings (1977) highlight a list of possible reasons why

[1] The semi-logarithmic functional form, which applies logs to the dependent variable only, is commonly used in econometrics because its coefficients represent useful concepts that are easily interpreted. An example of an semi log model is $\ln(P) = \propto + \beta_1 S + \beta_2 D + u$.

elasticity estimates may deviate from each other. Probably the most important factor confronting a researcher is what price to use. According to Askari and Cummings (1977), prices most frequently cited in estimating supply response include the price of the crop actually received by farmers, the ratio of the price of the crop to some consumer price index, the ratio of the price of the crop received by farmers to some index of the farmers inputs and the ratio of the price of crop received by farmers to some index of prices of competitive crops. Basically any two studies that employ variations of each of these prices are bound to come up with different results, and yet none of these prices might be the right one to use.

The fundamental issue though, according to Askari and Cummings (1977) is using the price that captures better the farmer's motives especially regarding why a farmer might want to produce more of a particular commodity. If output is changing because a farmer wants to keep his own consumption of the crop the same, in the face of rising input costs, then using the ratio of crop price to some index of input prices is advisable. If producers are motivated by the need to buy more goods then crop prices deflated by some index of consumer prices could be reasonable. The same type of thinking applies on the consumption side when deciding what type of price to apply in demand estimation, and how different forms of variables are used in the estimation.

Data for Estimating Demand and Supply Elasticities

Estimation of demand elasticities for at least 23 countries in the model can be challenging due to data requirements. In some cases, reliable price and income data could not be found as in the case of Cuba, Pakistan and South Korea. Whenever such challenges were encountered the elasticities were not estimated, but existing literature was used to establish reasonable estimates of elasticities. One such source was the

Food and Agricultural Policy Research Institute (FAPRI), a joint project of University of Missouri and Iowa State University, maintains a downloadable elasticity database.

In the world sugar model, individual country demand is modeled as a function of income and domestic prices in the country concerned. Sugar consumption information for each country was sourced from the US Department of Agriculture (www.fas.usda.gov/psdonline/). Income (GDP) and exchange rate information for most countries was obtained from the Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, also known as the Penn World Tables (Heston, et al., 2011). Domestic sugar prices were obtained from individual country statistical databases. In many of the countries being modeled, the departments of agriculture or the central statistical offices maintain wholesale domestic sugar prices, and they were used in estimating demand. The World Bank was used as a source of the Caribbean World Sugar price, from which it also possible to ascertain what a country's domestic prices are if the trade distortions prevalent in a country are known.

To estimate supply production, acreage and farm gate price data was obtained from the Food and Agricultural Organization.

Estimation of Supply Elasticities

Unlike the straightforward estimation of demand elasticities, there are some methodological difficulties in the estimation of supply response. The main difficulty is that neither planned output nor anticipated price is observable because weather and other environmental factors can make observed output deviate from planned output. On prices, the farmer knows only the current and historical prices. Most time series studies for crops use acreage as a proxy for output because acreage is thought to be more subject to farmers control than output, while most researchers assume that that farmers anticipate prices from their knowledge of current and past information (Rao, 1980).

According to Nerlove (1956), the elasticity of acreage is probably only a lower limit to the supply elasticity. He further on states that farmers react not to last year's price, but rather to the price they expect, and this expected price depends only to a limited extent on what last year's price was. Therefore, because anticipated prices are not observable, it can be hypothesized that they change from year $t - 1$ to year t by some fraction of the difference between the actual and the anticipated price in year $t - 1$. Since the goal is estimating the supply elasticity, Nerlove (1956) presents a pathway by which an acreage equation can be used to derive at least the lower bound supply elasticities for each of the countries being modeled. Assuming that acreage (X_t) is a linear function of expected price (P_t^*) and an error term (u_t)

$$X_t = a_0 + a_1 P_t^* + u_t \tag{4-7}$$

and expected price can be defined by the following equation

$$P_t^* - P_{t-1}^* = \beta(P_{t-1} - P_{t-1}^*) \text{ where } 0 < \beta \leq 1 \tag{4-8}$$

Price elasticities can be computed from the coefficient of price in equation in an acreage equation, however, since Equation 4-7 has unobservable expected prices it cannot be used to estimate elasticities directly. By substituting Equation 4-8 into Equation 4-7 Nerlove (1956) shows that acreage can be described by the following equation

$$X_t = \pi_0 + \pi_1 P_{t-1} + \pi_2 X_{t-1} + V_t \tag{4-9}$$

whose variables are all observable, and is the acreage equation used in studies such as Koo (2002) and Elobeid and Beghin (2006) to estimate supply. Nerlove (1956) showed that the parameter estimates from Equation 4-9 can be related to those of Equation 4-8 such that

$$\begin{aligned} \pi_2 &= 1 - \beta \\ \pi_1 &= a_1\beta \\ \pi_0 &= a_0\beta \end{aligned} \tag{4-10}$$

Therefore defining a_1, which is the elasticity estimate, given that the estimated equation is in log form.

$$a_1 = \frac{\pi_1}{\beta} \tag{4-11}$$

Having derived an elasticity estimate, the supply equation for a country can then be traced using mean sugar quantities and prices. In the case of Brazil, the above approach can be applied to determine the supply elasticity as the example in Table 4-2 shows. Given that $\pi_2 = 1 - \beta$ and $\pi_2 = 0.6412$ then $\beta = 0.3588$. Also $\pi_1 = a_1\beta$ this implies that $a_1 = \frac{\pi_1}{\beta} = \frac{0.1262}{0.3588} = 0.3517$ is the elasticity of supply as measured by the response of acreage to expected price of sugar. The same approach is used to determine the elasticity of supply for the rest of the countries in the model. Supply elasticities for countries in the model are estimated and presented in Table 4-3. For those countries where it was hard to source reasonable data to allow an econometric estimation, other studies are used for elasticity information.

The author's estimates of supply response, shown in the first column of Table 4-3, tended to yield higher elasticity values particularly for the African group of countries, India, Indonesia and Pakistan than other studies. This could be due to the reasons cited earlier in relation to the suitability of the type of price data used in the estimation of supply response. Sensitivity analysis will be employed where halving, doubling and tripling elasticity estimates will be implemented then document how the model responds to such changes.

Estimation of Transportation Costs

Transport costs between countries can pose a formidable barrier to trade, similar in effects to tariffs and institutional constraints (Binkley and Harrer, 1981). While transport costs are thought to reflect unalterable geographic factors like distance between traders, and hence not policy relevant, there is evidence, however, that many factors can influence rates, and rates need not be proportional to distance (Binkley and Harrer, 1981). In their econometric model Binkley and Harrer (1981) emphasize that a producer's competitive position in world grain trade depends upon its competitive advantage in shipping as well as in production. Their study provides evidence that distance maybe of relatively small consequence for large vessels, suggesting that a critical factor in shipping advantage is the nature of the port systems at origin and in destinations. Port facilities available, such as channel depth, determine the types of ships that can be handled efficiently as they affect the size of the ships that can be handled and how quickly loading and off loading can be done. They also investigate the effect of trading volume on routes and find that location of ports with respect to major trading routes matters. Implying that a port located along a major route may lower shipping rates than one less favorably located. The Binkley and Harrer (1981) model takes the following form

$$\mathrm{RATE} = \mathrm{f}(\mathrm{DIST}, \mathrm{SIZE}, \mathrm{TERMS}, \mathrm{QUART}, \mathrm{FLAG}, \mathrm{VOL}, \mathrm{PORT}) \tag{4-12}$$

where RATE is the rate (dollars per long ton), DIST (voyage distance in thousands of miles), SIZE is shipment size (thousands of tons), TERMS are loading and unloading terms, FLAG is the registry of ship (US or foreign). QUART is the quarter in which the shipment occurred, VOL refers to volume of grain for the route in question and PORT refers to the origin and destination ports for the shipment.

Martin and Clement (1982) carried out an analysis of factors affecting freight rates at the port. They specifically looked at port specific factors using a case study of the lower Columbia River Port area. Their study, similar to Binkley and Harrer (1981), focused on grains, but both are significant because of the nature of international ocean freight market. Both papers emphasize that ocean freight market largely consists of tramp ships and ocean liners. The main difference between the two being that ocean liners tend to belong to shipping conferences which determine routes, work on fixed rates, transporting packaged finished goods, refrigerated products, and containers for example. The tramp shipping market consists of hundreds of private shipping firms, based all over the world, operating thousands of ships which are available for hire on spot-demand basis. They primarily transport dry bulk commodities like grains and sugar, and do not maintain fixed routes, but instead respond to market forces. Due to the fact that tramp shipping tends to be less disorganized, charter contract negotiations between the ship owner and potential shipper are represented by brokers who communicate through the Baltic Shipping Exchange in London and other major stock exchanges of the world (Martin and Clement, 1982).

The model proposed by Martin and Clement (1982) is a slight modification of the work that was done by Binkley and Harrer a year earlier. It takes the form

$$\mathrm{RATE} = \mathrm{f}(\mathrm{DIST}, \mathrm{TON}, \mathrm{LD}, \mathrm{DWT}, \mathrm{AGE}, \mathrm{DTH}, \mathrm{P}, \mathrm{T}, \mathrm{FUEL}, \mathrm{F}, \mathrm{EX}) \qquad (4\text{-}13)$$

where DIST is distance, TON is shipment size in long tons, LD is lay days, DWT is ship size in dead weight tons, AGE is age of ship, DTH is the maximum depth at the destination port, P is size of port, T is terms of shipping, FUEL is bunker fuel price in dollars per barrel, F is flag of registry, and EX refers to US west coast grain exports. Martin and Clement (1982) argue that the Binkley model may not be well specified because it has a coefficient of determination of 46%, and they also suggest that the model appears unstable due to a heavy reliance on indicator variables. Nonetheless the results of these studies are similar.

The data

To estimate the per unit cost of freight a dataset for the year 2001 was purchased from Maritime Research Inc. of New Jersey. The dataset had information on the week in which a ship was chartered to transport sugar from a production to a demand region. Specified in the dataset are port of origin, destination, the rate charged for each shipment per ton, the terms of shipment and who the shipping (charter) company was. The data describes the main sources and destinations of sugar traded globally in 2001. Specifically Brazil and Cuba accounted for 50% of global sugar charters in 2001. Data is not always available to describe the exact country where the sugar was being shipped to, instead in some cases “Europe” is the destination, which refers to Western Europe, including Russia.

Because data on sugar charters from Maritime Research Inc. is available until 2001, the original intention was to use oil and ship charter indices to extrapolate data to 2009. For that reason the Baltic Dry Index (BDI) and the Crude Oil Light Sweet NYMEX are utilized. The BDI is a number issued daily by the London-based Baltic Exchange. Not restricted to Baltic Sea countries, the index tracks worldwide international shipping prices of various dry bulk cargoes. The index provides "an assessment of the price of moving the major raw materials by sea. Taking in 26 shipping routes measured on a time charter and voyage basis, the index covers Handymax, Panamax, and Capesize dry bulk carriers carrying a range of commodities including coal, iron ore and grain. Economists and stock market investors read it because the index measures the demand for shipping capacity versus the supply of dry bulk carriers.

Estimation

The cost of shipping a ton of sugar is estimated as a function of the following variables, distance, size of the load, the loading rate (time it takes to load a ship with the sugar cargo), discharge rate. Also included are the Baltic Dry Index (BDI) and the oil index (OILSW.IDX). The data purchased did not have information on the size of the load, which captures information on the size of shipments between countries in the World Sugar Model (WSM). Binkley and Harrer, 1981 indicate that this is an important determinant of cost of shipping. It has been shown in econometrics that OLS estimators are biased and inconsistent for the case of omitted explanatory variables. It has further been shown the instrumental variable technique or two stage least squares (TSLS) can be used to obtain consistent estimators in the presence of omitted variables (Wooldridge, 2003). Consider a simple model

$$\mathrm{RATE} = \mathrm{f}(\mathrm{DIST}, \mathrm{LOAD\ SIZE},\ \ \mathrm{LR},\ \ \mathrm{DR},\ \ \mathrm{BDI},\ \ \mathrm{OIL},\ \ \mathrm{LT}, \mathrm{DT}, \mathrm{SEASON}) \qquad (4\text{-}14)$$

where we do not have data for LOAD SIZE when sugar is transported between the 23 countries in the model. Since neglecting LOAD SIZE results in biased and inconsistent estimators, in this case the problem is solved by first running a regression that predicts LOAD SIZE. In the second stage, where the cost of transporting a ton of sugar is estimated, then predicted load size $\left(\widehat{LOAD\ SIZE}\right)$ is used where there otherwise would have been an omitted variable. Assuming that it takes the following functional form

$$\mathrm{LOAD\ SIZE} = \mathrm{f(SHIPSIZE, DIST, LR, DR, LT, DT)} \qquad (4\text{-}15)$$

To understand the size of load from different parts of the world, the following variables need to be taken into consideration. First the different ship sizes that operate in the ocean freight industry are a factor. In terms of how much cargo in tons they carry, there are four types of ship sizes Handysize (10,000 to 35,000), Handymax (35,000 to 59,000), Panamax (60,000 to 80,000) and Capesize (100,000 and over). Also in deciding on the size of the load, distance, the loading and discharge abilities of ports should be factors. Given this information, Table 4-5 provides the parameter estimates of a model that fits the following regression

$$\mathrm{LOAD\ SIZE} = \alpha_0 + \alpha_1 \mathrm{D}_1 + \alpha_2 \mathrm{D}_2 + \alpha_3 \mathrm{DIST} + \alpha_4 \mathrm{LR} + \alpha_5 \mathrm{DR} + \alpha_6 \mathrm{DIST}^2 \qquad (4\text{-}16)$$

D_1 and D_2 are dummy variables for Handymax and Capsize respectively, and they are being compared to the Handysize. The model only has two dummy variables instead of three because there were no ships that fit the Panamax category in the sample data set. Having predicted the size of the load, then SIZE is used in the next stage of the estimation to predict the freight costs per ton. The regression model for rate is specified as follows

$$\mathrm{RATE} = \mathrm{f}(DIST, \widehat{LOAD\ SIZE}, LR, DR, BDI, OIL, LT, DT, SEASON) \qquad (4\text{-}17)$$

where LR is the loading rate, DR is the discharge rate, BDI is the Baltic Dry Index, OIL refers to the Crude Oil Light Sweet Index traded on the New York Mercantile Exchange, and LT is the loading time while DT is the discharge time. Because of the seasonal nature of sugar harvesting, a variable that captures the time of the year the shipping is done is also included.

Results of the analysis

Five variations of model based on Equation 4-17 were estimated, and they differ from each other mostly because some variables are added and others dropped based on their explanatory power. Model 1 (in Table 4-6) uses the explanatory variables distance, size of load, loading rate, discharge rate, the BDI and OIL indices to predict cost of shipment. In model 2 the BDI is dropped due to a lack of explanatory power, and its place ‘distance squared’ is included. The process is repeated in models 3 to 5, with model 5 chosen as the best to estimate the cost of shipping sugar between countries per ton. Model 5 is chosen over model 4 because according to model 4 there is a negative relationship between OIL prices and cost of shipping, which is not expected. Instead it is expected that the cost of shipping is positively correlated to oil prices.

The estimated model indicates that at the 5% level of significance the variables that are significant in explaining the variation in freight cost per ton are distance, size of load, loading rate, discharge rate, squared distance and the squared size. The rest of the variables are not significant. As with Binkely and Harrer (1981), while the coefficient for distance is positive (0.00197), that for the square of distance is negative (-1.97E-07) which is indicative of a declining effect as distance increases. The estimated coefficients on the shipment size and size squared are -0.0009 and 1.09E-08, which according to Binkley and Harrer (1981) suggest the presence of scale economies over a certain range. The loading and discharge rates measure the degree of mechanization at the ports. There is a significant negative relationship between the degree of port mechanization and the cost of shipping. In other words, it costs more to ship a unit of sugar the more time it spends at a loading or discharge port. The Baltic Dry Index is not a significant explanatory variable at the 5% level, while the oil index is significant at the

10%, but does not have the right sign. As expected the loading and discharge times, in models 3 and 4, are positively related to the cost of shipping.

Given that the data used was for the year 2001, however its estimates are used to determine the cost of shipping for the year 2009. To make the 2001 estimated applicable to 2009, two options were considered. The first was to assume they remain unchanged. The second was to compute a factor that measured how much the BDI and OIL indices have changed between 2001 and 2009, then multiply the regression estimates by the scaling factor. Multiplying the regression estimates from Equation 4-16 by the scaling factor (2.5) results in cost estimates that are higher in some cases almost double the rates reported by F.O. Licht[2], a leading authority on information on soft commodities, agriculture, food policy, markets and trade. For this reason, the first option that assumed unchanging estimates over the decade is adopted.

Commercial shipping companies were approached for shipping cost data when this model was being built. The information that they provided did not cover all the routes in the model, hence the process of econometrically estimating shipping costs per ton was undertaken. However, the information they provided was useful in testing how accurate the prediction model was. Table 4-7 presents information for six routes from Brazil, Cuba, Guatemala, India, South Africa and Thailand, were actual values are compared to what the model predicted. Based on this information it appears that the model under-predicted the cost of shipping from Brazil by 15% on average. It appears to have been inaccurate by about 18 and 38 percent for Guatemala and India, while being modestly accurate, with an error under 10% for sugar originating from South

[2] http://www.agra-net.com/portal2/home.jsp

Africa and Thailand. Overall it appears the model over-predicts on average the cost of shipping by 7 percent. The results of the estimated transportation costs are presented in the form of a matrix and are posted in Table 4-8.

Tariffs and subsidies

Major sugar traders like the EU and the United States have complicated systems that allow sugar from a select group of countries at preferential tariff rates. There are import quotas that the EU imposes on ACP countries and India. There are import quotas imposed by the USA as part of the TRQ system it uses to control sugar trade. There is a €339/ton tax the EU imposes on imports from non preferential countries, while the USA imposes a tax of 1.4606 cents/KG for cane and 3.6606 cents/KG for beet. There is a long list of import taxes and export subsidies that other countries impose. Detailed individual country trade policies are presented in Table 4-9.

Table 4-1. Demand elasticities used in the model

	Author Estimated	Various sources		FAPRI
Africa Group	-1.066	-0.015[7]		
Australia	-0.002			
Brazil	-0.009	-0.246[3]	-0.224[3]	-0.08
Canada		-0.240[4]		-0.06
Caribbean Group	-0.100			
China	-0.258; -0.228			
Colombia		-0.478[7]		-0.09
Cuba		-0.040[5]	-0.160[5]	-0.09
European Union	-0.584	-0.120[6]	-0.320[6]	
Guatemala		-0.016[7]		-0.11
India	-0.063			-0.14
Indonesia	-0.085			
Japan	-0.810	-0.344[3]	-0.260; -0.002[7]	
Malaysia		-0.100[8]	-0.450[8]	-0.06
Mexico	-0.019			
Middle East				-0.12
Pacific Group	-0.040[9]			
Pakistan				-0.08
Russia				-0.19
South Africa	-0.083	-0.381[3]	-0.370[3]	-0.13
South Korea		-0.389[3]	-0.256[3]	-0.09
Thailand		-0.675[3]	-0.358[3]	-0.12
United States		-0.140[10]; -0.042[7]		

Table 4-2. Regression estimates for an acreage equation for Brazil

Dependent variable	$\ln(\text{Area})$	
Independent Variables		Parameter Estimates
Intercept		5.1165 (2.6624)
Producer Price (US $/ton)	$\ln(P_{t-1})$	0.1262 (0.0537)
Area allocated to production	$\ln(\text{Area}_{t-1})$	0.6412 (0.1812)
Trend	t	0.0144 (0.0057)
Regression R^2		0.9690
Durbin H test		-0.4687 (0.3196)

Source: Author's own computation.

[3] Gemmill (1979).
[4] Tweeten et al. (1997).
[5] Dye and Sicotte (2004).
[6] Poonyth et al. (2000).
[7] Devadoss et al. (1995).
[8] http://www.fao.org/DOCREP/005/X0513E/x0513e05.htm
[9] Hafi et al. (1993).
[10] Schmitz et al. (2006). CAFTA and US Sugar.

Table 4-3. Supply elasticities for different countries in the model

	Author Estimated	Various sources	FAPRI (Beet)	FAPRI (Cane)
Africa Group	1.742	0.017[7]		
Australia		0.066[7]		0.14
Brazil	0.352			0.20
Canada	2.932		0.17	
Caribbean Group	0.084			
China	0.631; 0.196		0.13	0.09
Colombia		0.018[7]		0.11
Cuba				0.08
European Union	0.180		0.60	0.31
Guatemala		0.008[7]		0.10
India	1.854	0.978[7]		0.21
Indonesia	2.068	0.320[7]		0.08
Japan		0.336[7]	0.22	0.18
Malaysia	0.480			0.09
Mexico	0.082	0.891[7]		0.20
Middle East			0.06	0.06
Pacific Group		0.070[11]		
Pakistan	3.021	0.589	0.04	0.07
Russia	0.103		0.10	
South Africa	0.461	0.047[7]		0.12
South Korea		0.144[7]		
Thailand	0.162			0.17
United States	0.420	0.271		

Table 4-4. Comparison of ship sizes

Ship Classification	Dead Weight Tons	% of World Fleet	% of Dry Bulk Traffic
Capesize	100,000+	10%	62%
Panamax	60,000-80,000	19%	20%
Supramax	45,000-59,000	37%	18% w/ Handysize
Handysize	15,000-35,000	34%	18% w/ Supramax

Source: Wikipedia

[11] Reddy (2009).

Table 4-5. Determinants of the size of load

	Estimate	Standard Error
Intercept	4,350**	1,494
Handymax	14,552***	2,537
Capesize	64,534***	6,083
Distance	3.3767***	0.5779
Loading Rate	0.6554***	0.1128
Discharge Rate	1.9747***	0.3286
Square of distance	-0.0002**	0.0001
Adjusted R Squared		0.5199
No of observations		337
Durbin Watson		2.005

,* indicate significance at the 95% and 99% level respectively

Table 4-6. Determinants of the cost of shipping a ton of sugar

	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	31.0491***	28.4475***	21.0283***	29.5033***	27.7389***
	(2.7398)	(2.7176)	(2.7854)	(2.8689)	(1.3465)
Distance	0.0020***	0.0033***	0.0042***	0.0044***	0.00429***
	(0.0002)	(0.0005)	(0.0006)	(0.0005)	(0.0005)
Size of load	-0.0003***	-0.0003***	-0.0006***	-0.0009***	-0.0009***
	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0001)
Loading Rate	-0.0005***	-0.0005***		-0.0003429***	-0.0004***
	(0.0001)	(0.0001)		(0.0001)	(0.0001)
Discharge Rate	-0.0022***	-0.0021***		-0.00137***	-0.00166***
	(0.0003)	(0.0003)		(0.0004)	(0.0003)
Baltic Dry Index	0.0007			0.00231	
	(0.0022)			(0.0020)	
OIL (NYMEX)	-0.21191	-0.1690	-0.1163	-0.2601*	
	(0.1724)	(0.0913)	(0.0912)	(0.1561)	
Squared distance		-1.22E-07**	-1.80E-07***	-1.97E-07***	-1.92E-7***
		(0.0000)	(0.0000)	(0.000)	(4.67E-8)
Loading time[12]			0.1706***	0.07443	
			(0.0540)	(0.0611)	
Discharge time[13]			0.17538***	0.04103	
			(0.0453)	(0.0518)	
Squared size				1.09E-08***	1.20E-8***
				(0.0000)	(1.53E-9)
Adjusted R Squared	0.5207	0.5301	0.5276	0.6141	0.6072
D-Watson	2.000	1.995	2.054	2.057	2.033
No of observations	298	298	298	298	298

*, **, *** indicate significance at the 90%, 95% and 99% level respectively.

[12] Loading time is defined as the size of load over loading rate.

[13] Discharge time is defined as size of load over the discharge rate.

Table 4-7. A comparison of the actual shipping values and predicted values for certain routes

	Africa group	Australia	Brazil	Canada	Caribbean group	China	Colombia	Cuba	EU	Guatemala	India	Indonesia	Japan	Malaysia	Mexico	Pacific group	Pakistan	Russia	South Africa	South Korea	Thailand	UA E	USA
Actual Values																							
Brazil						65			42		60	66	69	66	44		59	42		68			45
Cuba									41									38					
Guatemala						46			35			42	42	42				35		42			
India						24						18		18			21			25			
South Africa						49			40			44	48	44				35		47			
Thailand						25						18	27	18				42		25			
Predicted Values																							
Brazil						47			42		50	48	48	54	44		50	45		46			43
Cuba						49			36									43					
Guatemala						48			43			48	47	55				47		46			
India						38						27		29			14			38			
South Africa						50			50			41	53	48				46		50			
Thailand						24						17	30	21				45		26			
Percent difference between actual and predicted																							
Brazil						-28			-1		-16	-27	-31	-17	0		-15	6		-32			-3
Cuba									-11									13					
Guatemala						4			23			15	13	30				33		10			
India						57						49		63			-35			54			
South Africa						2			26			-8	10	9				31		7			
Thailand						-3						-3	12	15				8		4			

Source: Author's own computation.

Table 4-8. Estimated transportation costs ($ per ton) between countries

	African Group	Australia	Brazil	Canada	Caribbean Group	China	Colombia	Cuba	EU	Guatemala	India	Indonesia	Japan	Malaysia	Mexico	Pacific Group	Pakistan	Russia	S. Africa	S. Korea	Thailand	Middle East	USA
African Group	7	42	43	50	48	44	48	49	44	49	26	25	47	39	49	48	27	35	21	44	39	28	52
Australia	52	85	141	61	141	52	141	141	59	141	132	39	53	50	141	113	56	59	132	52	126	59	64
Brazil	42	51	10	42	34	47	38	39	42	43	50	48	48	54	44	50	50	45	38	46	51	51	43
Canada	46	250	250	10	250	47	250	250	30	250	250	47	50	55	250	250	50	39	250	47	250	51	18
Caribbean Group	46	50	33	26	9	48	15	17	35	25	50	47	50	54	25	48	50	41	45	48	48	51	26
China	42	250	250	50	250	8	250	250	48	250	250	26	17	32	250	250	43	47	250	11	250	45	52
Colombia	47	52	39	26	17	49	11	15	38	21	52	47	50	54	23	49	51	44	49	48	51	52	25
Cuba	47	51	39	23	18	49	14	10	36	22	51	47	50	54	19	49	51	43	49	48	49	51	21
EU	43	47	41	32	35	47	37	36	8	42	44	48	48	53	40	47	46	32	46	47	48	46	37
Guatemala	48	52	45	33	27	48	21	23	43	11	52	48	47	55	29	46	51	47	52	46	50	51	32
India	24	40	47	50	47	38	48	48	44	47	7	27	42	29	48	45	14	35	33	38	30	19	52
Indonesia	24	250	250	51	250	26	250	250	48	250	250	7	32	19	250	250	33	44	250	28	250	36	52
Japan	44	250	250	51	250	16	250	250	47	250	250	30	9	36	250	250	45	48	250	13	250	47	53
Malaysia	32	250	250	51	250	26	250	250	48	250	250	13	31	13	250	250	30	42	250	27	250	34	52
Mexico	48	52	45	28	27	49	23	20	41	28	52	45	50	52	11	51	51	46	52	48	48	52	26
Pacific Group	49	40	61	53	61	39	59	60	49	56	60	38	38	47	61	19	51	48	61	38	54	53	54
Pakistan	24	250	250	50	250	40	250	250	44	250	250	30	44	33	250	250	10	34	250	40	250	16	52
Russia	34	47	43	42	41	48	42	42	33	45	35	44	49	49	45	46	37	7	41	47	45	38	46
South Africa	23	71	65	54	74	50	76	76	50	78	63	41	53	48	78	78	40	46	32	50	72	41	56
South Korea	43	250	250	50	250	12	250	250	48	250	250	28	14	34	250	250	44	47	250	7	250	46	53
Thailand	37	36	48	50	46	24	47	46	49	46	31	17	30	21	45	40	35	45	42	26	8	39	50
Middle East	24	250	250	50	250	42	250	250	44	250	250	33	46	37	250	250	16	35	250	42	250	10	52
USA	47	250	250	17	250	47	250	250	33	250	250	47	50	55	250	250	51	41	250	47	250	51	11

Source: Author's own computation.
The level of transport cost that is set to prevent shipping into a particular j region is $250.

Table 4-9. Sugar policies for countries in world sugar model[21]

		Tariff[22]	Subsidy
Africa	Madagascar 5%; Mauritius 65% customs duty;		
Australia	Ended administered price arrangements in 1989 and removed import tariffs in 1997.	Free	
Brazil	Imposes a 17.5% tariff on imports from non-MERCOSUL countries (Brazil has zero imports). There is a subsidy (BRR 5.07/MT) targeting high cost growers in Northeast region.	16% CET	
Canada	Imposes a tariff on refined imports from $22.05/ton to $30.86/ton depending on the polarization of sugar. Developing countries pay zero duty on raw sugar, and Australia and Cuba, from where the bulk of the raw sugar is imported, are exempt from duty.	Free	
Caribbean			
China	China charged as of 2004 an import duty rate of 50% to MFN and an in-quota rate of 15% for both raw beet and cane sugar. The general tariff was 125% in 2004. This is the latest information available from ICTB website.	125%	
Colombia	Sugar imports from the Andean community are allowed duty free. The basic duty on raw and refined sugar imports from the non-Andean Community is 20%. Export subsidies of 2.5% of the f.o.b. value for centrifugal and panela sugar is received by Colombian exporters. This is not provided for exports to the United States. Colombia sets guaranteed sugar prices close to the world price.	20%	2.5%
Cuba	Imposed in 2008 an ad valorem tariff of 40% for raw sugar beet and cane imports. The rate is 30% for MFN.	40%	
European Union	Export refunds are paid to exporters to cover the gap between the EU price and the world price when sugar is sold from intervention stocks. Production quotas are used to limit the sugar eligible for support. The surplus of A and B production above domestic consumption is exported with subsidy. C quota sugar must be exported at world prices. Sugar imported from ACP is re-exported with subsidy. The with-in quota rate is EUR 98/ton and out-of-quota rate is EUR339/ton. Everything-But-Arms is limited by quotas until 2009 when duty-free access is allowed.	EUR339/ton	World Price less EU Price in 2009
Guatemala	Raw beet or cane sugar imported are levied a 20% duty.	20%	
India	Imposes an import duty of 60% plus INR 850/ton countervailing duty on raw sugar. National minimum support price for sugarcane (INR 620/ton in 2001/02) are augmented by state governments by another 20% to 50%. There is a transport subsidy to encourage exports (INR 140/ton in 2001/02).	60%	
Indonesia	Imposes a tariff rate of 20% on raw cane sugar and 25% on beet sugar. To support farmers' incomes, the government also sets a sugar floor price (IDR 2,600/kg in 2001/02).	25%	
Japan	Imposes a prohibitive duty on refined sugar of JPY 21.5/kg with an additional surcharge of JPY 53.88/kg. But imports of raw sugar are duty free.	Free	

[21] Most of the information on this is extracted from Elobeid and Beghin (2005) and International Customs Tariffs Bureau (http://www.bitd.org/).

[22] Refers to tariffs on raw sugar for processing in mills to WSE.

Table 4-9. Continued.

		Tariff[23]	Subsidy
Malaysia	Controls sugar imports through quota restrictions by licenses. The country imposes a 5% ad valorem rate on sugar imports as well as a specific tax of MYR 426.7/ton. Wholesale and retail sugar prices are controlled (MYR 1,345/ton for the wholesale price and MYR 1.4/kg for the retail price).	5%	
Middle East	Iran imposes a tariff rate of 19% on raw sugar imports. Saudi Arabia free. Syria 1%; Lebanon 5%; Jordan free.		
Mexico	Imposes a duty of $0.3166/kg on U.S. sugar imports and $0.3958/kg on third-country imports. Every year the government announces the reference price for standard sugar, which is used to calculate the price paid to sugarcane growers. Growers are given 57% of the wholesale reference price of a ton of standard sugar (MX pesos 4,561.08/ton in 2001/02).		
Pacific			
Pakistan	Imposes a 15% import tariff on raw and refined sugar.	15%	
Russia	Seasonal tariffs are added during periods of peak domestic production to protect producers and support prices. The in-quota tariff rate was 5% but no less than EUR 0.015/kg and the over quota rate was set at 40% for raw and white sugar but no less than EUR 0.12/kg for raw sugar and EUR 0.14/kg for white sugar. The over-quota seasonal rate was 50% but not less than EUR 0.15 /kg for raw sugar and EUR 0.18/kg for white sugar.		
South Africa	Imposes duties based on the difference between the world price and a set reference price. The duty was ZAR 784/ton in 2001 and ZAR 1312/ton in July 2002. South Africa provides import access of sugar to Swaziland, Mozambique, Zambia, and Zimbabwe.	Free	
South Korea	Imposes a 3% tariff on raw sugar and a temporary 50% tariff on refined sugar. The wholesale sugar price is controlled by the government.	3%	
Thailand	Maintains high internal sugar prices using quotas and import tariffs. The country has a 65% in-quota tariff rate and a 99% out-of-quota tariff rate.	99%	
USA	Has an MFN import duty of 0.625/lb (raw value) but most quota suppliers are exempt. The above-TRQ rate is 15.36¢/lb for raw sugar and 16.21¢/lb for refined sugar (TRQ was 1.361 million tons in 2001 and 1.289 million tons in 2002 and it was 1,117,195 tons in 2009). Under NAFTA, Mexico has duty-free access to the U.S. of up to 25,000 MTRV until 2008 when all imports from Mexico are duty free. The TRQ for countries in the model are: Africa 88115; Australia 87402; Brazil 152691; Caribbean 57802; Colombia 25273; Guatemala 50546; India 8424; Mexico 7258; Pacific 9477; South Africa 24220; Thailand 14743.	Cane: 1.4606 c/KG Beet: 3.6606 c/KG	

[23] Refers to tariffs on raw sugar for processing in mills to WSE.

CHAPTER 5
RESULTS

The results reported in this chapter are in line with events that occurred in the European Union (EU) with regard to the timeline they followed in liberalizing the EU sugar industry. The study shows how the rest of the world (especially ACP countries) is impacted under different EU policies. The study describes how changes in the preferential or support price from €631.9 ($796.19) in 2006 to €541.5 ($752.69) in 2009 and eventually to €404.4 ($536.63) in 2010 (all prices are for white sugar equivalents [WSE] in metric tons) affected its trading partners.

Five scenarios are presented. First, the 2009 baseline results are compared with those generated using 2006 values, the year in which reforms in the EU sugar policy were first introduced. Initially, the price floor is varied alone to understand its singular impact (i.e., whether the price floor alone was an effective policy tool). Second, the European Union is allowed to completely liberalize supply prices by removing all forms of sugar tariff and non-tariff barriers. Third, after the European Union and the United States are allowed to simultaneously liberalize their trade policies, the impact on the rest of the world is quantified. Fourth, the study analyzes the impact of a US only liberalization and fifth all countries are allowed to liberalize their supply prices by removing all forms of protection, and then the result is compared to the baseline model.

Scenario I: The World Sugar Model

To recap, the most prevalent policy instrument in most regions that the model incorporates is the ad-valorem tariff. Ad-valorem tariffs are based on value of sugar as compared to the per unit taxes which are based on fixed quantities. In addition, other countries have other forms of protection, like in the United States, where there is a tariff rate quota (TRQ), which restricts imports to a select group of countries, with an over quota tariff pegged at 1.4606 US cents/KG for sugarcane and 3.6606 US cents/KG for sugar beets. In the European Union, alongside the price floor, which is a production support tool, there are quotas that restrict imports to a handful of countries, mostly ACP members. There are also import tariffs pegged at €33.9/100KG for both sugar beets and sugarcane, along with an export subsidy, equivalent to the difference between world prices and the EU price floor. The export subsidy is pegged at $300/ton for the baseline model.

Baseline model results for 2009 are presented for 23 regions in Table 5-1. They indicate that on the demand side, the European Union had the most expensive sugar and the highest supply price in the world, which was indicative of the high price floor in 2009. Also, markets clear in 11 of the 23 regions. With respect to production, the model predicted that India produced the most sugar, followed by Brazil, the European Union, China, the United States, and Thailand, respectively. Regarding consumption, the model predicted as expected that India was the largest consumer in 2009, followed by the European Union, China, Brazil, the United States, and Russia. EU policy dictated that only A & B sugars could be sold within its borders, implying that C-sugar had to be exported and any imports re-exported. Therefore, consumption in the model is capped at 17.4 million tons, as that was the amount equivalent to A & B production. Producer surplus was used to measure welfare, showing benefits accruing at $942 million for African farmers, $236 million for Caribbean farmers, and about $62 million for Fiji (the only country in the Pacific Group) farmers in 2009.

The accuracy of the model was evaluated (Table 5-2) by comparing the actual production and consumption values that happened in the base year with what the model predicted. It appears that on average the model was much more accurate in predicting production, which it under predicted by 3.3 percent on average, while consumption was under predicted on average by 12.1 percent.

The results presented in Table 5-3 show production response to changes in the price floor using the 2009 baseline model for the 2006 to 2010 prices, which represented a 36 percent drop in price, from €631.9 to €404.4. According to this model, the effects of lowering the price floor alone are negligible. Supply prices change slightly in the positive direction, except for the United States where prices remain unchanged. Production changes are also negligible (less than one percent) for most countries in the model.

Scenario II: Impact of EU liberalization

In scenario I, we considered what happened to the global sugar markets if the EU price floor alone was lowered. Scenario II considers the impact of completely liberalizing the European Union while trade distortions in other countries remain unchanged. According to the model, EU liberalization drives the supply price in Europe down by 53%, to $368.18 per ton (Table 5-4). The Caribbean countries and the United States are the two other regions where prices fall, by 30.6% and 1.8%, respectively, as a result of the EU action. In the rest of the world, supply prices rise, ranging from 8.5% in the Middle East to about 31.2% in Brazil. It is noteworthy that prices go up by 13.2% in Africa and by 26.4% in the Pacific (Fiji), two regions that are part of the EU/ACP sugar protocol. The implication is that African and Pacific farmers would benefit from EU liberalization while those in the Caribbean would not.

The model predicts that allowing only the European Union to liberalize results in global production increasing by an average of 5.8% per year. However, in the EU, production would fall by 9.4%, while US production would decline by just under 1%. The Caribbean records a 3.1% drop in this scenario. The effects on consumption are mostly felt in Europe, where liberalization results in consumption going up 61.2%. In the baseline model, we imposed a binding consumption constraint on Europe to limit it to 17.4 million tons of A plus B sugar. Lifting this constraint has a huge impact on consumer surplus.

With liberalization, the European Union would cease being an exporter to become a large net importer, increasing EU imports of sugar by about 809%. Prior to the 2006 reforms, the European Union imported under 2 million tons of sugar per year, mostly from ACP countries and India. Liberalization, however, allows more imported sugar from Brazil, Australia, and Thailand, countries that previously did not have preferential access to the EU market. With regards to the welfare effects, there is interest in understanding how policy changes would affect ACP countries. It appears that while liberalization would result in the producer surplus increasing by 22.9% and 30.6% for Africa and the Pacific (Fiji), respectively, it would decrease by a significant 32.6% for the Caribbean countries. This could be an indication that Caribbean sugar revenues are highly dependent on EU policies, while the same cannot be said about Africa or Fiji. African countries in the model produced about 3.3 million tons of sugar under the baseline model, of which only 0.8 million tons was traded internationally, mainly as part of the EU/ACP sugar protocol. The protocol absorbed about 25% of the African sugar; hence, it is understandable that no matter how important the EU market is to African exports, the amounts exported are not enough to cause African farmers to suffer as a result of liberalization, unlike with the Caribbean farmers. Lastly, the increase in global prices is felt by consumers across the globe as consumer surplus drops in most countries, except the European Union, the Caribbean, and United States where it increased by 159.8%, 6.6%, and 0.3%, respectively.

Scenario III: Impact of EU and US liberalization

When both the European Union and the United States are assume to completely liberalize (Table 5-5), supply prices decline by 50% in the European Union, by 25.8% in the United States, and by 30.5% in the Caribbean. In contrast, supply prices increase in the rest of the world, ranging from 10.4% in China to 30.8% in Brazil. It is interesting to note that production declines by close percentage levels in the European Union (9.4%) and the United States (8.4%). Therefore, when these two major producers and consumers of sugar liberalize, global sugar production increases by 5.8%, with much of that accounted for by India (18.8%), Malaysia (14.4%), and South Africa (11.7%). Percentage production changes for other countries are in the single digits.

Once more, liberalization results in a 61% increase in sugar consumption in the European Union, but only a 1.9% increase in the United States. Allowing these two countries to liberalize their sugar supply prices also makes them net importers, which benefits US and EU consumers.

Scenario IV: Impact of US-Only Liberalization

If the United States liberalizes its sugar markets while the rest of the world remains unchanged global sugar prices would increase for 20 of the 23 regions in the model by about two to three percent for most countries as reported in Table 5-6. Supply prices would remain unchanged in China and drop by 4.4% in Colombia, while the

United States would face a 38.9% decline in supply prices as a result of the liberalization policy. The effects on production are relatively small, less than one percent in most countries, while in the United States production would decline by almost 13%. United States sugar imports would increase by 115% as a result of liberalization, while producer surplus drops by 43.6% and consumer surplus ticks up by almost six percent. It appears from the model that a United States only liberalization has a modest impact on ACP countries with their producer surplus increasing by between 1.35% in the Caribbean, 2.19% in the African region, and 2.91% in the Pacific region respectively. Most of the gains to United States liberalization would be realized by American consumers who would pay lower sugar prices, and global exporters who would find a bigger market to sell to in the United States.

Scenario V: Impact of Free Trade Across All Countries

The effect of global liberalization on supply prices is that prices go up in 20 of the 23 regions of the model (Table 5-7). The three regions experiencing declines are the Caribbean, the European Union, and the United States, where prices fall by 26.7%, 47.6%, and 22.2%, respectively. The net effect is that liberalization drives up supply prices by 22.9% on average. Under free trade, liberalization spurs global production by 8.8%. Specifically production would go up by 4.8% in Africa, 11.4% in the Pacific, and 25.4% in India. Regions that experienced a drop in supply prices, the Caribbean, the European Union, and the United States, also experience production declines of 2.6%, 8.9%, and 7.2%, respectively. The average consumption increases across all countries are driven mostly by increases in the European Union (60%), Thailand (16%), and China (14.8%), respectively. Most countries experience slight consumption declines, but they are not large enough to offset the consumption increases of the European Union, Thailand, and China.

In regards to trade, the most notable aspect of liberalization is that EU imports of sugar would increase from less than 2 million tons per year to about 13.4 million per year to satisfy the increase in demand in the European Union. A similar trend is experienced in the United States, where imports increase by 65.9%, compared to the baseline. Based on producer surplus, while liberalization would be good for Africa, whose surplus would increase by 30.7%, to $1,232 million, and for the Pacific, where it would increase by 46.1%, to $91.3 million, it would be bad for the Caribbean, whose welfare (producer surplus) would decline by 27.8%, to $170.7 million.

Impact of Trade Liberalization on ACP Countries

During the ACP sugar protocol years, each member country was allocated a quota which allowed its sugar duty-free access to the European Union. ACP countries were allocated 701 thousand, 428 thousand, and 165 thousand metric tons for the African, Caribbean, and Pacific groups, respectively. Table 5-8 reports the benefits of liberalization, as measured by the producer surplus, for three regions of the ACP. It appears liberalization would be beneficial for ACP countries at least when looked at in the aggregate using producer surplus.

Prior to liberalization, each country got paid based on the proportion of the quota amounts they supplied to the European Union. To illustrate this point, column (3) of Table 5-9 indicates that the Congo had a 1.5% share of the quota, so it got paid 1.5% of the ACP protocol revenues, assuming it fulfilled its quota for that year. With liberalization, quotas ceased to exist and producer gains for each country were determined by other factors, such as each country compared with other countries in producing sugar in the post-liberalization period. By liberalizing the world markets, sugar producers in less developed countries would have to compete with Brazil, Thailand, and Australia who tend to be low-cost producers.

To arrive at a more accurate country specific prediction of the impacts of liberalization, supply and demand elasticities for each ACP country are needed. Since this information was challenging to estimate, the study used regional groupings to circumvent the data challenges. Despite these challenges, some predictions can still be made about how individual countries are likely to fare in the post-liberalization period. In Table 5-9, the fourth column presents total supply available in each country in 2006. The fifth column shows total exports by each of these countries in the same year. The sixth column presents exports as a share of total supply and the seventh column shows the proportion of exports that went to the European Union in 2006. In the African region, Mauritius exported 71%, followed by Swaziland (16%), the Congo (10%), and the rest of the countries (6% or less each) of their total sugar supply to the European Union.

Based on these figures, it is highly likely that Mauritius at 71% would experience more significant revenue drop than would the Congo at 10% as a result of liberalization. The model predicts that the Caribbean countries would experience negative producer surplus changes as liberalization occurs. Their exports shares to the European Union are on average higher than most ACP countries, so a 36% drop in support prices would affect them negatively. On the other hand, Fiji, which exported 37% of its production to the European Union, has a positive gain in producer surplus after liberalization. The possible explanation for this is that Fiji has proximal sugar markets (e.g., China and Japan) that are capable of absorbing its production.

There is a general consensus that EU and US subsidies depress global sugar prices to the detriment of farmers in less developed countries. According to the International Sugar Organization (ISO, 2006) sugar production has been growing in less developed countries, especially in Sub-Saharan Africa, in response to incentives like the "Everything but Arms" agreement on sugar quota access and the zero duty after 2009. Some countries that have experienced high sugar production growth are Sudan, Ethiopia, Tanzania, Mozambique, Zambia, Malawi, and Uganda, with the last four being part of the sugar protocol. Some of the factors that have shifted production in their favor are high sugar yields, long milling campaigns (8 to 19 months), low labor and transportation costs, and low processing costs (Nyberg, 2005).

Orden (2008), in an IFPRI discussion paper, ranks the lowest cost sugar producers in the 2004–05 period, with Brazil as the least costly producer, followed by Malawi, Zimbabwe, Australia, Swaziland, Zambia, Guatemala, South Africa, China, Thailand, Mozambique, Tanzania, India, and Mexico, respectively. This model indicates that if only the European Union liberalized its sugar markets, global consumption would go up 5.8%, and EU sugar consumption would increase from 17 million tons to about 28 million tons per year, or a 61.2% increase. Global sugar consumption would increase 8.8% in the free market scenario due to consumption increases of 60% in the European Union, 16% in Thailand, and 14.8% in China, respectively. To meet this demand, sugar production would have to increase in some parts of the world, and it is reasonable to argue that the lowest cost producers would respond positively. For that reason, it is plausible that the supply price in the African region would increase as more demand is anticipated, thus pushing production upwards. According to Conforti et al. (2007), losers from EU trade reforms would tend to be (a) high-cost producers such as the Caribbean countries, and (b) countries such as Swaziland and Mauritius who were not eligible for expanded access under the EBA at the time. This is consistent with what this trade model is predicting.

Table 5-1. The baseline model

	PRICE		PRODUCTION	CONSUMPTION	TRADE		WELFARE	
	Supply Price US$/Ton	Demand Price US$/Ton	Production ('000) MT	Consumption ('000) MT	Imports ('000) MT	Exports ('000) MT	Producer Surplus $Million	Consumer Surplus $Million
African Group	318.14	318.14	3,246.2	5,211.8	2,752.0	789.1	942.44	2,701.14
Australia	243.23	243.23	5,355.0	1,414.1		3,939.4	1,181.03	24,995.10
Brazil	248.60	288.37	27,812.0	13,538.0		14,276.0	5,908.55	12,405.20
Canada	318.12	318.12	105.0	1,849.0	1,746.5		28.33	5,122.24
Caribbean Group	493.23	493.23	503.1	342.0	267.0	428.0	235.99	818.64
China	315.71	710.35	14,114.0	14,114.0			3,862.50	14,144.90
Colombia	286.29	343.55	2,269.7	2,244.4		25.3	629.29	2,138.21
Cuba	267.42	374.38	1,294.1	790.2		503.5	334.16	936.68
EU	789.29	1,558.97	15,933.0	17,440.0	1,507.0		11,399.20	16,640.00
Guatemala	258.19	309.82	2,256.3	825.7		1,430.5	579.78	2,148.18
India	280.72	449.15	28,001.0	25,412.0		2,588.4	4,004.64	88,794.40
Indonesia	309.99	387.48	2,229.3	5,030.8	2,800.0		557.72	25,308.80
Japan	324.26	324.26	699.6	4,365.9	3,661.9		209.34	7,570.44
Malaysia	314.75	330.48	78.3	1,642.1	1,560.0		16.38	972.08
Middle East	327.32	327.32	1,270.1	6,934.3	5,670.0		408.14	47,364.00
Mexico	314.45	314.45	5,349.1	6,562.5	1,817.0	604.0	1,543.76	16,799.50
Pacific Group	258.90	258.90	285.2	63.9		221.4	62.48	658.83
Pakistan	322.14	370.46	3,630.6	4,653.3	1,020.0		1,104.83	7,000.85
Russia	320.96	320.96	3,024.5	7,125.5	4,100.0		878.16	14,594.20
South Africa	267.47	267.47	2,386.0	2,169.6		216.2	492.41	2,396.38
South Korea	320.01	329.61	0.0	1,536.1	1,540.0		0.00	1,439.30
Thailand	266.24	529.81	7,030.6	2,542.5		4,484.7	1,677.04	1,334.05
USA	534.08	534.08	7,729.2	8,794.1	1,065.2		3,456.13	32,373.50
	334.76	421.85	134,601.9	134,601.8	29,506.7	29,506.7		

Source: Author's own computation.

Table 5-2. Accuracy of prediction of the model

	Actual		Predicted			
	Consumption ('000) MT	Production ('000) MT	Consumption ('000) MT	Production ('000) MT	% Consumption Difference	% Production Difference
African Group	3,296.9	3,558.8	5,211.8	3,246.2	-58.1	8.8
Australia	1,384.1	5,065.5	1,414.1	5,355.0	-2.2	-5.7
Brazil	12,574.7	30,437.5	13,538.0	27,812.0	-7.7	8.6
Canada	1,559.1	104.3	1,849.0	105.0	-18.6	-0.6
Caribbean Group	327.3	496.0	342.0	503.1	-4.5	-1.4
China	15,195.4	12,879.0	14,114.0	14,114.0	7.1	-9.6
Colombia	1,792.3	2,328.8	2,244.4	2,269.7	-25.2	2.5
Cuba	781.7	1,300.0	790.2	1,294.1	-1.1	0.5
European Union	20,004.9	15,795.0	17,440.0	15,933.0	12.8	-0.9
Guatemala	783.9	2,255.0	825.7	2,256.3	-5.3	-0.1
India	25,442.0	24,125.0	25,412.0	28,001.0	0.1	-16.1
Indonesia	4,820.1	2,013.3	5,030.8	2,229.3	-4.4	-10.7
Japan	2,637.6	923.0	4,365.9	699.6	-65.5	24.2
Malaysia	1,448.6	48.0	1,642.1	78.3	-13.4	-63.0
Middle East	6,339.7	1,309.5	6,934.3	1,270.1	-9.4	3.0
Mexico	5,709.5	5,587.3	6,562.5	5,349.1	-14.9	4.3
Pacific Group	62.2	282.0	63.9	285.2	-2.7	-1.1
Pakistan	4,544.5	3,471.8	4,653.3	3,630.6	-2.4	-4.6
Russia	6,457.0	3,082.8	7,125.5	3,024.5	-10.4	1.9
South Africa	1,761.3	2,404.5	2,169.6	2,386.0	-23.2	0.8
South Korea	1,300.4	0.0	1,536.1	0.0		
Thailand	2,284.3	6,643.8	2,542.5	7,030.6	-11.3	-5.8
United States	8,273.7	7,151.0	8,794.1	7,729.2	-6.3	-8.1
		Average Difference			-12.1	-3.3

Source: Author's own computation.

Table 5-3. The baseline model compared with years 2006 and 2010

	Effect of Supply Prices					Effect on Production				
	2009 Supply Price US$/Ton	2006 Supply Price US$/Ton	2010 Supply Price US$/Ton	2006 to 2009 % Change	2009 to 2010 % Change	2009 Production ('000) MT	2006 Production ('000) MT	2010 Production ('000) MT	2006 to 2009 % Change	2009 to 2010 % Change
African Group	318.14	318.97	317.08	0.261	-0.003	3,246.2	3,247.6	3,244.3	0.043	-0.059
Australia	243.23	244.06	242.17	0.341	-0.004	5,355.0	5,358.4	5,350.6	0.063	-0.082
Brazil	248.60	249.43	247.54	0.334	-0.004	27,812.0	27,839.0	27,777.0	0.097	-0.126
Canada	318.12	318.95	317.06	0.261	-0.003	105.0	105.0	104.9	0.076	-0.095
Caribbean Group	493.23	494.06	492.17	0.168	-0.002	503.1	503.2	503.0	0.018	-0.020
China	315.71	315.71	315.71	0.000	0.000	14,114.0	14,114.0	14,114.0	0.000	0.000
Colombia	286.29	286.29	286.29	0.000	0.000	2,269.7	2,269.7	2,269.7	0.000	0.000
Cuba	267.42	268.25	266.36	0.310	-0.004	1,294.1	1,294.4	1,293.8	0.023	-0.023
EU	789.29	790.12	601.98	0.105	-0.237	15,933.0	15,773.0	16,136.0	-1.004	1.274
Guatemala	258.19	259.02	257.13	0.321	-0.004	2,256.3	2,256.4	2,256.3	0.004	0.000
India	280.72	281.55	279.66	0.296	-0.004	28,001.0	28,082.0	27,897.0	0.289	-0.371
Indonesia	309.99	310.82	308.93	0.268	-0.003	2,229.3	2,231.6	2,226.4	0.103	-0.130
Japan	324.26	325.09	323.20	0.256	-0.003	699.6	699.9	699.3	0.040	-0.050
Malaysia	314.75	315.58	313.69	0.264	-0.003	78.3	78.4	78.1	0.177	-0.225
Middle East	327.32	328.15	326.26	0.254	-0.003	1,270.1	1,270.2	1,269.9	0.008	-0.016
Mexico	314.45	315.28	313.39	0.264	-0.003	5,349.1	5,351.5	5,346.2	0.045	-0.054
Pacific Group	258.90	259.73	257.84	0.321	-0.004	285.2	285.5	284.9	0.102	-0.126
Pakistan	322.14	322.97	321.08	0.258	-0.003	3,630.6	3,631.7	3,629.3	0.030	-0.036
Russia	320.96	321.79	319.90	0.259	-0.003	3,024.5	3,025.9	3,022.5	0.046	-0.066
South Africa	267.47	268.30	266.41	0.310	-0.004	2,386.0	2,389.4	2,381.7	0.142	-0.180
South Korea	320.01	320.84	318.95	0.259	-0.003	0.0	0.0	0.0	0.022	-0.022
Thailand	266.24	267.07	265.18	0.312	-0.004	7,030.6	7,035.2	7,024.8	0.065	-0.082
USA	534.08	534.08	534.08	0.000	0.000	7,729.2	7,729.2	7,729.2	0.000	0.000

Source: Author's own computation.

Table 5-4. Impact of EU liberalization

	Supply Price US$/Ton	% Price Change	Production ('000) MT	% Production Change	Consumption ('000) MT	% Consumption Change	Imports ('000) MT	% Imports Change	Exports ('000) MT	% Exports Change	Producer Surplus $Million	% PS Change	Consumer Surplus $Million	% CS Change
African Group	360.18	13.2	3,321.2	3.6	5,000.4	-6.3	1,765.0	-41.4	88.1	-88.8	1,080.49	22.85	2,486.47	-12.18
Australia	312.18	28.3	5,638.1	4.9	1,411.3	-0.2			4,230.4	6.7	1,560.01	29.96	24,897.70	-0.36
Brazil	326.18	31.2	30,336.0	8.6	12,873.0	-4.7			17,483.0	21.3	8,164.11	36.07	11,216.80	-9.08
Canada	368.18	15.7	110.0	7.0	1,832.3	-1.3	1,727.4	-2.1			33.71	28.17	5,030.10	-2.63
Caribbean Group	342.18	-30.6	488.0	-3.1	352.8	3.2		-100.0	135.2	-68.6	161.13	-32.58	871.12	6.59
China	350.18	10.9	14,524.0	2.5	13,568.0	-3.3			956.0		4,356.02	11.01	13,071.60	-6.57
Colombia	342.18	19.5	2,297.6	1.1	2,165.4	-3.2			132.3	389.9	756.92	18.68	1,990.34	-6.38
Cuba	345.18	29.1	1,320.1	1.9	753.9	-4.3			566.0	11.8	435.80	28.72	852.63	-8.49
EU	368.18	-53.4	14,342.0	-9.4	28,323.0	61.2	14,000.0	809.1			5,024.57	-52.97	43,887.10	159.78
Guatemala	335.18	29.8	2,262.8	0.3	811.1	-1.7			1,453.5	1.4	753.74	28.63	2,072.57	-3.36
India	336.18	19.8	33,428.0	17.7	25,089.0	-1.2			8,340.4	202.7	5,708.06	38.51	86,553.80	-2.30
Indonesia	351.18	13.3	2,343.6	8.0	5,005.1	-0.8	2,660.0	-7.9			651.90	26.81	25,050.50	-1.60
Japan	365.18	12.6	713.3	3.1	4,314.4	-1.9	3,598.0	-2.8			238.25	21.88	7,392.85	-3.68
Malaysia	356.18	13.2	85.2	13.7	1,581.7	-5.7	1,500.0	-6.4			19.76	32.93	901.96	-11.11
Middle East	355.18	8.5	1,274.0	0.6	6,920.2	-0.4	5,650.0	-0.7			443.58	15.79	47,171.00	-0.74
Mexico	364.18	15.8	5,488.2	3.8	6,498.8	-1.4	1,616.0	-16.5	604.0	0.0	1,813.24	25.95	16,474.70	-2.85
Pacific Group	327.18	26.4	308.4	7.7	63.6	-0.3			244.5	10.0	82.74	30.57	654.48	-0.62
Pakistan	350.18	8.7	3,665.6	1.7	4,603.4	-1.9	938.0	-14.7			1,207.12	16.77	6,851.60	-3.83
Russia	371.18	15.6	3,114.7	4.4	7,038.1	-1.8	3,924.0	-6.4			1,032.32	25.86	14,238.50	-3.56
South Africa	337.18	26.1	2,670.1	11.1	2,101.1	-2.9			569.2	152.6	668.65	33.34	2,247.52	-5.81
South Korea	361.18	12.9	0.0	1.5	1,501.4	-3.5	1,501.0	-3.8			0.00	21.10	1,374.90	-6.96
Thailand	335.18	25.9	7,409.5	5.0	2,210.1	-12.2			5,199.7	14.9	2,174.79	27.71	1,008.05	-22.96
USA	524.30	-1.8	7,683.1	-0.6	8,805.8	0.1	1,123.0	5.4			3,380.70	-2.18	32,459.70	0.27
	355.8374	6.3	142,823.4	5.8	142,824.0	5.8	40,002.4	32.5	40,002.4	32.5				

Source: Author's own computation.

Table 5-5. Impact of simultaneous EU and USA liberalization

	Supply Price US$/Ton	% Price Change	Production ('000) MT	% Production Change	Consumption ('000) MT	% Consumption Change	Imports ('000) MT	% Imports Change	Exports ('000) MT	% Exports Change	Producer Surplus $Million	% PS Change	Consumer Surplus $Million	% CS Change
African Group	386.46	21.5	3,368.1	3.8	4,868.3	-6.6	1,500.0	-45.5		-100.0	1,168.39	23.97	2,356.79	-12.75
Australia	310.86	27.8	5,632.7	5.2	1,411.4	-0.2			4,218.0	7.1	1,552.59	31.46	24,899.50	-0.38
Brazil	325.22	30.8	30,305.0	9.0	12,881.0	-4.9			17,381.0	21.7	8,135.05	37.68	11,231.10	-9.46
Canada	394.74	24.1	112.6	7.3	1,823.4	-1.4	1,710.0	-2.1			36.66	29.42	4,981.54	-2.75
Caribbean Group	342.91	-30.5	488.1	-3.0	352.8	3.1		-100.0	135.0	-68.5	161.49	-31.57	870.86	6.38
China	348.62	10.4	14,506.0	2.8	13,593.0	-3.7			913.0		4,333.40	12.19	13,119.20	-7.25
Colombia	344.10	20.2	2,298.6	1.3	2,162.7	-3.6			136.0	438.1	761.34	20.98	1,985.35	-7.15
Cuba	347.35	29.9	1,320.8	2.1	752.9	-4.7			568.0	12.8	438.66	31.28	850.34	-9.22
EU	394.70	-50.0	14,443.0	-9.4	28,081.0	61.0	13,600.0	802.5			5,406.28	-52.57	43,139.10	159.25
Guatemala	336.53	30.3	2,262.9	0.3	810.8	-1.8			1,452.0	1.5	756.80	30.53	2,071.25	-3.58
India	334.47	19.1	33,261.0	18.8	25,099.0	-1.2			8,162.0	215.3	5,651.10	41.11	86,622.40	-2.45
Indonesia	377.62	21.8	2,417.0	8.4	4,988.6	-0.8	2,570.0	-8.2			714.84	28.17	24,885.30	-1.67
Japan	391.89	20.9	722.2	3.2	4,280.8	-1.9	3,563.0	-2.7			257.42	22.97	7,278.05	-3.86
Malaysia	382.38	21.5	89.5	14.4	1,543.6	-6.0	1,450.0	-7.1			22.05	34.65	858.97	-11.64
Middle East	381.07	16.4	1,277.7	0.6	6,907.0	-0.4	5,630.0	-0.7			476.61	16.78	46,992.00	-0.79
Mexico	392.79	24.9	5,568.2	4.1	6,462.1	-1.5	894.0	-50.8		-100.0	1,971.41	27.70	16,289.30	-3.04
Pacific Group	326.53	26.1	308.2	8.0	63.6	-0.3			245.0	10.7	82.54	32.12	654.52	-0.65
Pakistan	375.89	16.7	3,697.7	1.8	4,557.7	-2.1	860.0	-15.7			1,301.78	17.83	6,716.16	-4.07
Russia	397.58	23.9	3,162.1	4.5	6,992.2	-1.9	3,824.0	-6.7			1,115.18	26.99	14,053.30	-3.71
South Africa	335.79	25.5	2,664.5	11.7	2,102.5	-3.1			562.0	159.9	664.94	35.04	2,250.44	-6.09
South Korea	387.64	21.1	0.0	1.6	1,479.0	-3.7	1,479.0	-4.0			0.00	22.14	1,334.28	-7.30
Thailand	333.87	25.4	7,402.3	5.3	2,216.4	-12.8			5,186.0	15.6	2,165.10	29.10	1,013.81	-24.01
USA	396.44	-25.8	7,080.7	-8.4	8,958.5	1.9	1,878.0	76.3			2,436.87	-29.49	33,595.30	3.77
	362.85	8.4	142,388.9	5.8	142,388.3	5.8		32.0		32.0				

Source: Author's own computation.

Table 5-6. Impact of US only liberalization

	Supply Price US$/Ton	% Price Change	Production ('000) MT	% Production Change	Consumption ('000) MT	% Consumption Change	Imports ('000) MT	% Imports Change	Exports ('000) MT	% Exports Change	Producer Surplus $Million	% PS Change	Consumer Surplus $Million	% CS Change
African Group	324.48	2.0	3,257.5	0.3	5,179.9	-0.6	2,619.0	-4.8	701.0	-11.2	963.08	2.19	2,668.16	-1.22
Australia	249.57	2.6	5,381.0	0.5	1,413.8	0.0			3,967.0	0.7	1,215.09	2.88	24,986.10	-0.04
Brazil	254.94	2.6	28,018.0	0.7	13,484.0	-0.4			14,539.0	1.8	6,085.70	3.00	12,305.70	-0.80
Canada	324.46	2.0	105.6	0.6	1,846.9	-0.1	1,740.0	-0.4			28.99	2.36	5,110.51	-0.23
Caribbean Group	499.57	1.3	503.8	0.1	341.6	-0.1	266.0	-0.4	428.0	0.0	239.18	1.35	816.47	-0.26
China	315.71	0.0	14,114.0	0.0	14,114.0	0.0					3,862.50	0.00	14,144.90	0.00
Colombia	273.82	-4.4	2,263.5	-0.3	2,262.0	0.8			1.4	-94.4	601.04	-4.49	2,171.92	1.58
Cuba	277.07	3.6	1,297.4	0.3	785.7	-0.6			512.0	1.7	346.67	3.74	926.03	-1.14
EU	795.63	0.8	15,957.0	0.2	17,440.0	0.0	1,483.0	-1.6			11,500.40	0.89	16,640.00	0.00
Guatemala	266.25	3.1	2,257.0	0.0	824.2	-0.2			1,432.0	0.1	597.98	3.14	2,140.19	-0.37
India	287.06	2.3	28,622.0	2.2	25,375.0	-0.1			3,240.0	25.2	4,184.30	4.49	88,536.60	-0.29
Indonesia	316.33	2.0	2,246.9	0.8	5,026.9	-0.1	2,780.0	-0.7			571.92	2.55	25,269.00	-0.16
Japan	330.60	2.0	701.8	0.3	4,357.9	-0.2	3,659.6	-0.1			213.79	2.12	7,542.77	-0.37
Malaysia	321.09	2.0	79.3	1.4	1,632.8	-0.6	1,550.0	-0.6			16.88	3.05	961.17	-1.12
Middle East	333.66	1.9	1,271.0	0.1	6,931.1	0.0	5,660.0	-0.2			416.20	1.98	47,320.00	-0.09
Mexico	322.51	2.6	5,371.7	0.4	6,552.2	-0.2	1,180.0	-35.1		-100.0	1,587.00	2.80	16,746.60	-0.31
Pacific Group	265.24	2.4	287.4	0.8	63.8	0.0			223.6	1.0	64.29	2.91	658.43	-0.06
Pakistan	328.48	2.0	3,638.5	0.2	4,642.0	-0.2	1,000.0	-2.0			1,127.89	2.09	6,966.93	-0.48
Russia	327.30	2.0	3,035.9	0.4	7,114.5	-0.2	4,080.0	-0.5			897.39	2.19	14,549.00	-0.31
South Africa	273.81	2.4	2,411.9	1.1	2,163.4	-0.3			249.0	15.2	507.64	3.09	2,382.63	-0.57
South Korea	326.35	2.0	0.0	0.2	1,530.8	-0.3	1,530.0	-0.6			0.00	2.06	1,429.28	-0.70
Thailand	272.58	2.4	7,065.5	0.5	2,511.9	-1.2			4,550.0	1.5	1,721.76	2.67	1,302.14	-2.39
USA	326.16	-38.9	6,749.7	-12.7	9,042.5	2.8	2,295.4	115.5			1,950.90	-43.55	34,227.90	5.73
	330.99	0.02	134,636.3	0.0	134,636.9	0.0		1.1		1.1				

Source: Author’s own computation.

Table 5-7. Free world trade model

	Supply Price US$/Ton	% Price Change	Production ('000) MT	% Production Change	Consumption ('000) MT	% Consumption Change	Imports ('000) MT	% Imports Change	Exports ('000) MT	% Exports Change	Producer Surplus $Million	% PS Change	Consumer Surplus $Million	% CS Change
African Group	405.29	27.4	3,401.7	4.8	4,773.6	-8.4	1,372.0	-50.1		-100.0	1,232.14	30.74	2,265.99	-16.11
Australia	338.68	39.2	5,746.9	7.3	1,410.3	-0.3				10.2	1,710.91	44.87	24,860.30	-0.54
Brazil	344.05	38.4	30,918.0	11.2	13,127.0	-3.0			4,340.0	24.7	8,711.61	47.44	11,662.80	-5.98
Canada	413.57	30.0	114.5	9.1	1,817.1	-1.7	1,700.0	-2.7	17,798.0		38.80	36.98	4,947.26	-3.42
Caribbean Group	361.74	-26.7	490.0	-2.6	351.4	2.7		-100.0		-67.5	170.70	-27.67	864.23	5.57
China	413.80	31.1	15,282.0	8.3	16,202.0	14.8	920.0		139.0		5,304.26	37.33	18,639.90	31.78
Colombia	362.93	26.8	2,308.0	1.7	2,221.6	-1.0				242.0	804.72	27.88	2,094.92	-2.02
Cuba	366.18	36.9	1,327.1	2.6	793.0	0.3			86.4	6.0	463.60	38.74	943.17	0.69
EU	413.53	-47.6	14,514.0	-8.9	27,908.0	60.0	13,400.0	789.2	534.0		5,678.98	-50.18	42,611.90	156.08
Guatemala	355.36	37.6	2,264.4	0.4	818.5	-0.9				1.1	799.44	37.89	2,110.74	-1.74
India	353.30	25.9	35,104.0	25.4	25,760.0	1.4			1,446.0	261.2	6,294.93	57.19	91,246.60	2.76
Indonesia	405.44	30.8	2,494.3	11.9	5,021.8	-0.2	2,530.0	-9.6	9,350.0		783.17	40.42	25,218.60	-0.36
Japan	419.71	29.4	731.5	4.5	4,245.7	-2.8	3,515.0	-4.0			277.64	32.63	7,159.42	-5.43
Malaysia	410.20	30.3	94.2	20.3	1,531.5	-6.7	1,440.0	-7.7			24.61	50.25	845.58	-13.01
Middle East	399.90	22.2	1,280.4	0.8	6,897.5	-0.5	5,620.0	-0.9			500.70	22.68	46,862.00	-1.06
Mexico	411.62	30.9	5,620.9	5.1	6,438.0	-1.9	817.0	-55.0		-100.0	2,076.78	34.53	16,167.80	-3.76
Pacific Group	354.35	36.9	317.6	11.4	63.6	-0.5				14.7	91.25	46.06	652.75	-0.92
Pakistan	394.72	22.5	3,721.2	2.5	4,615.7	-0.8	895.0	-12.3	254.0		1,371.65	24.15	6,888.39	-1.61
Russia	416.41	29.7	3,196.0	5.7	6,959.5	-2.3	3,770.0	-8.0			1,175.05	33.81	13,921.90	-4.61
South Africa	354.62	32.6	2,741.2	14.9	2,084.0	-3.9				203.9	715.85	45.38	2,211.01	-7.74
South Korea	415.46	29.8	0.0	2.2	1,465.7	-4.6	1,470.0	-4.5	657.0		0.00	31.35	1,310.44	-8.95
Thailand	361.69	35.9	7,555.2	7.5	2,949.8	16.0				2.8	2,373.20	41.51	1,795.73	34.61
USA	415.27	-22.2	7,169.5	-7.2	8,936.0	1.6	1,767.4	65.9	4612		2,571.07	-25.61	33,426.80	3.25
	386.43	15.4	146,392.5	8.8	146,391.2	8.8		32.9		32.9				

Source: Author's own computation.

Table 5-8. Producer surplus comparison under different models

	Baseline Model	EU Only Liberalization	US Only liberalization	EU & USA Liberalize	Free World Trade
African Region	942.44	1,080.49	963.08	1,168.39	1,232.14
Caribbean Region	235.99	161.13	239.18	161.49	170.70
Pacific Region	62.48	82.74	64.29	82.54	91.25
Total	1,240.90	1,324.36	1,266.55	1,412.42	1,494.09

Source: Author's own computation.

Table 5-9. ACP sugar protocol quotas pre-reform and exports in 2006

	EU Quota ('000MT)	Percent of Quota	Total Supply ('000MT)	Exports ('000MT)	Exports / Total Supply	Share Exported to EU
Congo (Brazzaville)	10.20	1.50	106	41	0.39	0.10
Cote d'Ivoire	10.20	1.50	254	7	0.03	0.04
Kenya	-	0.00	777	11	0.01	0.00
Madagascar	10.80	1.50	276	10	0.04	0.04
Malawi	20.80	3.00	341	70	0.21	0.06
Mauritius	491.00	70.00	689	548	0.80	0.71
Mozambique			530	220	0.42	0.00
Swaziland	117.80	16.80	729	320	0.44	0.16
Tanzania	10.20	1.50	553	20	0.04	0.02
Zambia	-	0.00	300	140	0.47	0.00
Zimbabwe	30.20	4.30	469	149	0.32	0.06
Sub Total	701.20	100.00	5,024	1,536	0.31	0.00
Barbados	50.30	11.80	58	32	0.55	0.87
Belize	40.40	9.40	225	114	0.51	0.18
Guyana	159.40	37.20	243	161	0.66	0.66
Jamaica	118.70	27.70	274	140	0.51	0.43
St. Kitts and Nevis	15.60	3.60	6	0	-	2.60
Trinidad and Tobago	43.80	10.20	105	33	0.31	0.42
Sub Total	428.20	100.00	911	480	0.53	0.00
Fiji	165.35	100	445	270	0.61	0.37
Overall Total	1,294.75		6,380	2,286		

CHAPTER 6
SUMMARY AND CONCLUSIONS

Summary

This study was motivated by the idea that with reform of the European Union (EU) sugar policy, there was likelihood that the African, Caribbean and Pacific (ACP) countries could be adversely affected. There was a concern that by liberalizing its sugar trade regime, European Union prices could decline and sugar farmers in the ACP countries would no longer be paid two to three times world prices for the sugar they exported to the European Union. Specifically, preferential imports from the ACP were considered to be development aid, and were tied to the survival of the sugar Common Market Organization (CMO). This potentially presented problems if some countries were encouraged by EU policies to expand sugar production, while diversification to other crops could have been a better long term alternative. A sudden demise of the CMO potentially implied far reaching social costs in poor nations. The study intended to quantify the implication of sugar reforms by specifically understanding what would be the effects of EU sugar policy reform on world production. How would sugar production in the ACP and rest of the world be affected? Related to this was understanding what it meant for world sugar prices, i.e. what would be the direction of change as liberalization is implemented? The study uses producer and consumer surplus to quantify welfare gains and losses.

Pressure to reform EU sugar policies has been building over time. In the 1990s the consensus in agricultural policy circles, globally, was to move away from price support programs. So while other sectors were being reformed, sugar policy in most countries had been left unchanged because of its sensitive political nature. This fact, however, served to highlight sugar as a commodity that needed urgent reforms. Factors such as European Union enlargement, World Trade Organization commitments to the Uruguay Round, concessions to LDCs through Everything but Arms (EBA), and the Balkan Free Trade Agreement added pressure to change sugar policies in the European Union. Within the EU, the CMO for sugar was controversial, and it faced several legal challenges regarding its fairness and anti-competitive nature. The fairness argument centered on sugar beet farmers receiving support that was not available to other crops, and the distortions introduced such as that the CMO might be encouraging more European farmers into sugar beet production, than otherwise would be the case under market conditions. In short, domestic pressure in the EU came from competition monitors such as national authorities, the OECD, sugar user industries and consumer groups. Lack of competition is generally attributed to the fundamental terms of the CMO, which limited the ability of most efficient producers to develop, imposed limits on production of competing products and created barriers to entry of new producers. Some saw the arrangement the EU had with ACP countries as a way to protect itself from external competition.

Research Steps

Literature review was one of the first steps done to determine what model to be utilized in the study, understand how to best implement it, and compare its pros and cons to other trade models. Literature review covered work on the benefits of trade which strongly supports the notion that opening up economies to trade outweighs protectionist policies by increasing the variety of goods available in the market and raising productivity by making less expensive intermediate goods more available. Sugar trade models dating back to the 1960s were reviewed. The types of models that have been utilized in other research varied from econometric simulation, non-spatial equilibrium and general equilibrium models like GTAP. Although the base periods for studies reviewed were different, results from this dissertation do not deviate by much from what other researchers found to be the impact of liberalization on world prices.

A spatial equilibrium model was chosen as the tool to analyze the impacts of liberalization, hence demand and supply elasticities were required along with transportation costs to build the model. To understand the impact of the change in EU policies, the main sugar producing and consuming countries in the world were incorporated into the model. A world sugar trade model was developed to determine the direction of flows of sugar from production to consumption regions, and to determine equilibrium prices. The process involved estimating domestic supply and demand equations for all countries in the model, as well as estimating the cost of moving a unit of sugar between trading nations. The demand and supply elasticities and transport costs were then used to set up a baseline model which computes net social welfare, defined as the sum of producer and consumer surplus less transportation costs, using 2009 as the base year. The social welfare function is optimized using the Generalized Algebraic Modeling System (GAMS), a mathematical programming language.

Main Findings

The study considered the impact of five different policy scenarios. First, the 2009 baseline results are compared to the impact of price floor changes of 2006 and 2010. In the second, the EU is assumed to completely liberalize, in the third, both the EU and the US are assumed to completely liberalize, in the fourth only the US liberalizes, while in the fifth scenario, all countries of the world remove all trade restrictions.

Scenario one, reveals that world production, consumption and trade are almost insensitive to changes in the price floor, where the quantified effects are within one percent of the base values for all countries. In Scenario two, the model predicted that the European Union would cease to be an exporter and revert to a net importer status as it was decades ago. Specifically, African and Pacific farmers would realize increased welfare benefits (producer surplus) from liberalization while Caribbean farmers would experience a producer surplus decline due to the strong reliance of Caribbean agriculture on EU imports.

When the European Union and the United States were assumed to completely liberalize, supply prices declined sharply in the European Union, in the United States, and in the Caribbean. Allowing these two regions to liberalize their sugar economies makes them net importers, which benefits American and European consumers who get access to cheaper sugar under new policies.

By assuming the United States alone liberalizes its sugar markets, most of the gains would be realized by American consumers who would pay lower sugar prices, and global exporters who would find a bigger market to sell to in the United States. This would likely be a cause for concern for American farmers, as opening the US market would mean they would have to compete with countries with lower production costs. It is conceivable therefore that American sugar production would decline as a result, specifically sugar beets. Therefore farmers would have to diversify into other areas of agriculture.

The final scenario, where all countries are assumed to follow liberalization policies indicates that supply prices would go up in a majority of the countries, with only the Caribbean, the USA and the EU facing supply price declines. Global production would increase by almost nine percent, and most of that production would end up in the US and EU, two regions that would import more as a result of liberalization. Notably aggregate producer surplus would increase for ACP countries.

One of the main shortcomings of this study was the lack of supply and demand elasticities for ACP countries individually. Since this production and price information was not available by country, the study used regional groupings to circumvent the data challenges. It can be inferred from export data that, it is highly likely that Mauritius, a country that had more than half of its exports sent to the EU, is likely to experience a more significant revenue drop than Zimbabwe which exported less than 10% of its sugar to the EU, as a result of liberalization. Countries that exported more than 50% of their sugar to the EU like most Caribbean countries would experience negative producer surplus changes as liberalization occurs. Their exports shares to the European Union are on average higher than most ACP countries, so a 36% drop in support prices would affect them negatively.

This model indicates that if only the European Union liberalized its sugar markets, global consumption would increase about 6%, and EU sugar consumption would increase to about 28 million tons per year. Global sugar consumption would change increase by about 9% with full market liberalization. To meet this demand, sugar production would have to increase in some parts of the world, and it is reasonable to argue that the lowest cost producers would respond positively. This is the gap that is likely to be covered by the efficient producers in Africa and the Pacific.

Recommendations for Future Research

Given that the main aim of the study was to look at the impacts of policy changes on individual African, Caribbean and Pacific countries, there are still unanswered questions. As stated before, there was a lack of data, hence each of the eighteen ACP countries could not be incorporated explicitly into the mathematical programming model. As a way of developing this research further, there is a need to gather data and estimate demand and supply elasticities for each of the countries involved. The model as presented was insensitive to changes in the EU price floor alone. That is adjustments to the price floor do not result in changes in production, import and exports that are greater than one percent in magnitude. That is a puzzling result that requires further examination. It could be that the mathematical specification of the model is incorrect, even though other studies seem to suggest it is the right way to model price floors. So there is still room for more research into understanding how to model price floors.

Another area of concern is that the study does not take into consideration that most countries keep sugar stocks from year to year to smooth consumption. The study assumes a long run focus, were the effects of stocks is assumed away. However by using 2009 as the base year, it remains questionable whether this indeed was a long run study. So one more area of improvement could be to allow for stocks to be incorporated into the model and then assess the impacts on the results.

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