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A Spatial Price Equilibrium Analysis

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Zusammenfassung

Die Dissertation beschäftigt sich mit den Auswirkungen verschiedener Politikoptionen auf den Weltzuckermarkt. Dazu wird ein räumliches Preisgleichgewichtsmodell wie von Takayama und Judge vorgeschlagen mit hoher Abdeckung von Regionen und Politiken erstellt. Der Vorteil dieses Modelltyps gegenüber den in bisherigen Analysen verwendeten besteht in seiner Fähigkeit, die Annahme der Ursprungshomogenität (im Gegensatz zu Modellen, die auf dem Armington Ansatz basieren) mit der Möglichkeit zu kombinieren, bilaterale Handelsströme explizit abzubilden. Ein wesentlicher Nachteil ist die quasi-normative Natur des Ansatzes.

Nach der Einführung wird zunächst in Kapitel zwei der Weltzuckermarkt detailliert beschrieben und von anderen Agrarmärkten abgegrenzt sowie die Anforderungen an ein Gleichgewichtsmodell des Weltzuckermarktes diskutiert. Dann wird im dritten Kapitel eine Übersicht über verschiedene in der Vergangenheit verwendete Modellansätze gegeben und deren Ergebnisse ausgewertet.

Im vierten Kapitel wird ein Überblick die theoretische Entwicklung des Modellansatzes gegeben und schließlich das in der Dissertation verwendete Modell beschrieben. Das Modell umfasst 104 Zucker produzierende und 90 Zucker konsumierende Regionen. Nationale Handels- und Agrarpolitiken sowie eine Vielzahl regionaler und präferentieller Handelsabkommen sind im Modell berücksichtigt. Im zweiten Teil von Kapitel vier wird eine Analyse von vier Szenarien mit dem Modell durchgeführt. Diese umfassen eine Fortführung gegenwärtiger Politiken, ein WTO Abkommen, eine einseitige Liberalisierung des Zuckermarktes der EU sowie eine Liberalisierung der Zuckermärkte aller im Modell vertretenen Länder.

Im Abschlusskapitel werden einige Kernergebnisse zusammengefasst und eine Weiterentwicklung des Ansatzes diskutiert. Hier wird insbesondere auf das Problem der Quasi-Normativität eingegangen.

Schlagwörter:

Zucker, Partielle Gleichgewichtsmodelle, Räumliche Gleichgewichtsmodelle, Agrarpolitik

Abstract

The Dissertation at hand investigates the effects of different policy options on the world sugar market. A Spatial Price Equilibrium Model as suggested by Takayama and Judge is established. This model type has one considerable advantage over previously applied types which is its ability to combine the assumption of homogeneous goods regardless of origin (as opposed to Armington-based models) with the possibility to model bilateral trade flows explicitly. One major drawback of the approach is that is behaves in part like a normative model.

After the introductory chapter, a detailed description of the world sugar market and how it distinguishes from markets for other agricultural commodities is given. In this framework requirements of a valid equilibrium model of the world sugar market are discussed. In the third chapter various studies of the world sugar market based on equilibrium models are surveyed.

In the chapter four the development of the approach of spatial equilibrium modeling finally the model applied in this dissertation are described The model covers 104 sugar producing and 90 sugar consuming regions. National agricultural and trade policies as well as numerous regional and preferential trade agreements are accounted for. In the second part of chapter four, four scenarios are simulated with the model. These are a reference scenario in which current policies are maintained, a WTO agreement, a unilateral liberalization of sugar policies on the part of the EU as well as a multilateral liberalization of the sugar markets of all countries.

In the final chapter, some core results are summarized and further development of the applied approach especially possible solutions for the problem of quasi-normativity are discussed.

Keywords:

Sugar, Partial Equilibrium Models, Spatial Price Equilibrium Models, Agricultural Policy

Danksagung

Die vorliegende Studie ist der letzte und umfangreichste von fünf Aufsätzen, die im Rahmen meiner Dissertation ‚Partial Equilibrium Models in Agricultural Policy Analysis' an der Humboldt-Universität zu Berlin von 2003-2007 entstanden sind. Von den übrigen vier Aufsätzen, die im folgenden Absatz aufgelistet sind, sind drei in gemeinsamer Autorenschaft verfasst worden:

Mit Oliver Balkhausen, Martin Banse und Harald Grethe: Modellierung der Auswirkungen einer Entkopplung der Direktzahlungen in der EU auf die Flächenallokation und Wiederkäuerproduktion: Eine Analyse unterschiedlicher Modellergebnisse. *Agrarwirtschaft*. 54 (8): 351-365 (2005).

Mit Harald Grethe und Stefan Tangermann: Evolution, Current State and Future of EU Trade Preferences for Agricultural Products from North-African and Near-East Countries. *Journal of International Agricultural Trade and Development.* 2 (1): 109-133 (2005).

Mit Marie-Luise Rau: *Food Quality Standards in Equilibrium Models: A Discussion. of Current Modeling Approaches*. Tagungsbeitrag auf der 26. Konferenz der International Association of Agricultural Economists (IAAE), "Contributions of Agricultural Economics to Critical Policy Issues", 12. – 18. August 2006, Brisbane, Australien.

Ohne Koautor: *The application of spatial models in the analysis of bilateral trade flows: An alternative to the Armington approach for the world sugar market.* Working Paper Nr. 77 des Instituts für Wirtschafts- und Sozialwissenschaften des Landbaus, Landwirtschaftlich-Gärtnerische Fakultät, Humboldt-Universität zu Berlin (2006).

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ACP	Africa, Caribbean and Pacific
ALIC	Agriculture and Livestock Corporation
BDI	Baltic Dry Index
CACM	Central American Common Market
CAFTA-DR	Central America-Dominican Republic-United States Free Trade Agreement
CAP	Common Agricultural Policy
CAPRI	Common Agricultural Policy Regionalized Impact
CARD	Center for Agricultural and Rural Development
CES	Constant Elasticity of Substitution
CET	Constant Elasticity of Transformation
CGF	Corn Gluten Feed
cif	Cost, Insurance, Freight
CMO	Common Market Organization
COMESA	Common Market for Eastern and Southern Africa
Congo, D.R.	Democratic Republic of Congo
Congo, R.	Republic of Congo
EBA	Everything But Arms
EPA	Economic Partnership Agreement
EU	European Union
dwt	Deadweight Tons
exw	Ex Works
FAPRI	Food and Agricultural Policy Research Institute
fob	Free On Board
FTA	Free Trade Agreement
GAMS	General Algebraic Modeling System
GDP	Gross Domestic Product
GE	General Equilibrium
GSP	Generalized System of Preferences
GTAP	Global Trade Analysis Project
HFCS	High Fructose Corn Syrup
ICC	International Chamber of Commerce
ISO	International Sugar Organization

KT	Kuhn-Tucker
KKT	Karush-Kuhn-Tucker
LCP	Linear Complementarity Problem
LDC	Least Developed Country
LP	Linear Programming
MAFF	Ministry of Agriculture, Forestry and Fisheries
MCP	Mixed Complementarity Problem
MERCOSUR	Mercado Común del Sur
MFN	Most Favored Nation
MT	Metric Ton
NAFTA	North American Free Trade Agreement
NEI	Netherlands Economic Institute
NLP	Nonlinear Programming
NYBOT	New York Board of Trade
OJ	Official Journal
OLS	Ordinary Least Square
PE	Partial Equilibrium
PMP	Positive Mathematical Programming
QP	Quadratic Programming
Rs	Indian Rupees
SACU	Southern African Customs Union
SADC	Southern African Development Community
SITA	Statistics for International Trade Analysis
SPE	Spatial Price Equilibrium
SPS	Special Preferential Sugar
SSG	Special Safeguard
UNCTAD	United Nations Conference on Trade and Development
UR	Uruguay Round
URAA	Uruguay Round Agreement on Agriculture
USDA	United States Department of Agriculture
TRQ	Tariff Rate Quota
WSE	White Sugar Equivalents
WTO	World Trade Organization
ZAR	South African Rand

1 Introduction

Sugar is one of the most protected agricultural commodities world-wide. Many countries support their domestic markets by trade barriers and domestic policies. These are not only industrialized countries, like the European Union (EU), the USA and Japan where sugar prices are supported to be a multiple of the world market price (Mitchell, 2004), but also some developing countries such as South Africa or India and, of course, planned economies like Cuba and to some degree still China have highly distorting policies in place. Frequently, these are blamed to depress the world market price for sugar considerably, which is also confirmed by scientific analyses (Mitchell, 2004). While producers in the countries which protect their sugar markets are generally the beneficiaries and thus in favor of these policies, those countries which currently produce to world market conditions like Brazil, Thailand and Australia are hit by these distortions in their export interests and hence oppose them. Also consumers in the countries with high levels of protection are adversely affected, as well as the sugar using industry. Another group of beneficiaries of the protection of primarily industrialized countries are producers in countries which have preferential access to these markets and can sell their sugar for the high prices prevailing there. However, also some developing countries have granted preferential access to their sugar markets to other countries.

The Uruguay Round Agreement on Agriculture (URAA) did not bring about major changes to this situation. Trade barriers for imports in excess of possible tariff rate quotas (TRQs) are still prohibitive in the countries mentioned above. In recent years, however, several steps towards reforming the sector have been embarked upon by some of the protecting countries, most notably by the EU. The first substantial step towards opening the EU market for sugar was the adoption of the "Everything But Arms" (EBA) Initiative by the Council of the European Union[1] in 2001, which extended the Generalized System of Preferences (GSP) to duty and quota free market access for sugar from Least Developed Countries (LDCs) from 2009 onwards with an implementation period with gradually increasing duty free TRQs and tariff reductions.[2] The first major reform of the Common Market Organization (CMO)[3] for sugar followed after a long process of discussion in 2006 after it had been virtually immune

[1] Council Regulation (EC) 416/2001 (OJ L60, 01.03.2001, pp. 43-50).
[2] In the so-called Presidency Compromise for the 2006 CMO reform the Council agreed on a clause to 'automatically open the procedure to decide whether measures such as suspension or temporary withdrawal of trade concessions, surveillance or other safeguard measures need to be applied' in case the annual increase of a country's sugar exports under EBA exceeded 25%. Commission officials state, however, that this clause is not to be interpreted as a safeguard for EU market balance, but as an effort to tackle fraud in the form of triangular trade.
[3] Council Regulation (EC) 318/2006 (OJ L58, 20.02.2006, pp. 1-31).

in all former rounds of reforms of the EU's Common Agricultural Policy (CAP). Also the USA took in recent years steps in the direction of more openness by granting increased market access to its neighbors under several Free Trade Agreements (FTAs). It is, however, questionable whether the next farm bill will bring major changes to the overall current US sugar policies (Sapp, 2007).

In addition to the reform steps by single countries, the current round of WTO (World Trade Organization) negotiations has the potential to greatly impact sugar markets, although it is uncertain if and when such an agreement will be signed. If the July proposal by Chairman Falconer is taken as a benchmark for a possible agreement (Agra-Europe Weekly, 2007), the envisaged tariff cuts would bring an end to the prohibitive effect of Most Favored Nation (MFN) tariffs in all major distorting industrialized countries. Various external and internal pressures could furthermore lead countries to liberalization beyond a possible WTO agreement.

Any major steps of liberalization in the sugar market can be expected to have relatively great impacts on production, consumption, and prices. This is since the levels of protection in the sugar market exceed those in markets for other agricultural products significantly, and thus liberalization will have larger consequences. Besides the effects of liberalization on the global sugar market and the positions of big players like the EU, the USA or Brazil therein, it is especially interesting to look at the impacts it may have on the sugar sectors of countries which are beneficiaries of preferential trade arrangements. Trade preferences for sugar account for the bulk of the value of all agricultural trade preferences granted to developing countries (Grethe, 2005), which is due to the high gap between protected and world market prices. If these prices fall, the value of preferential market access will erode or may vanish completely for these countries.

Both the EU and the USA have a long tradition of preferential access commitments to their sugar markets and both are currently extending the number of beneficiaries and the overall quantities which they import on a preferential basis. In the case of the EU, preferential sugar imports started with the sugar protocol attached to the first Lomé Treaty with African, Caribbean and Pacific (ACP) countries which granted thirteen former colonies TRQ restricted access of a total of 1.3 million tons white sugar equivalents (WSE) to the EU market at guaranteed prices. Further market access will be given to the group of LDCs, which is to become unrestricted from 2009 onwards.[4] In the case of the USA, sugar has been imported under a quota system as a form of development aid for a long time.[5] The overall amount of preferential market access is currently expanded under the Central America-Dominican Republic-United States Free Trade Agreement (CAFTA-DR) and the North American Free Trade Agreement (NAFTA) (USDA, 2006).

Some of the countries which are beneficiaries of these agreements sell their entire production under preferential conditions and their industries are highly threatened by the erosion of these preferences. Others are competitive sugar producers and their sectors will though being negatively affected not shrink, because they can export their production to other importers. In many cases, this is likely to happen again under bilateral preferential agreements, which also exist in great number among developing countries and also include preferential market access for sugar. Due to the complex system of preferential trading arrangements governing the world sugar market, the result of a significant liberalization of trade will be the termination of many current trade flows and the establishment of new ones.

The results of possible liberalization scenarios on the world sugar market have been analyzed in various studies with equilibrium models.[6] Some of these studies used net-trade models, in which sugar is regarded a homogeneous good. In this category of models a country is either an importer or an exporter of sugar, but not both at the same time. Furthermore, it is not specified in such a model to which country an exporter exports or from where the imports of an importing country come. Preferential trade and how it is affected by policy changes must, therefore, be ignored by these models. All other model-based studies, which are unlike the former able to depict these situations, rely on the Armington Approach (Armington, 1969) and treat sugar from different origins as imperfect substitutes. The expectations expressed above, the termination of current preferential trade flows and the creation of new ones, which are shared by most experts, could not be reproduced by these models. A study which combines the strengths of both approaches, the treatment of sugar as a homogeneous good on the one hand and the ability to account for bilateral trade flows on the other hand, has not been published so far. In Nolte (2006) the attempts which were made by other modelers to overcome the problems of the Armington Approach are surveyed. As an alternative, the study suggests the application of the Spatial Price Equilibrium (SPE) modeling ap-

[4] Besides these two, there are some other preferential market access commitments in place which are of less importance in terms of quantities.
[5] The system of import quotas has been converted in a TRQ system after being challenged successfully in the General Agreements on Tariffs and Trade (GATT) in 1990 (Mitchell, 2004).

proach (Takayama and Judge, 1971), which in fact is able to depict bilateral trade flows under the assumption of homogeneous goods. The author constructs a small SPE model of the world sugar market and shows that under a liberalization scenario the results could comply with the expectations.

To be a useful tool for economic analysis, however, an equilibrium model should have the potential to provide insights which go beyond the ad hoc estimations of experts. Due to the rough regional aggregation and policy coverage, the model used by Nolte (2006) necessarily failed to do so. For this study, the SPE model is extended to the coverage of 90 consuming regions and 104 producing regions of sugar with a detailed depiction of domestic and trade policies. A special functional form for the supply curve of some producers which was developed by Nolte and Grethe (2007) is chosen to be able to depict the situation that these countries entirely stop the production of sugar in case the price falls too much. The objectives of this study are to analyze with the help of this model the following research questions:

- How will the situation on the world sugar market in the next decade develop, if no further policy changes are expected?

- In particular, what will be the situation after the implementation of those reforms which are already on the way, i.e. the full market access for LDCs to the EU from 2009 onwards, the 2006 reform of the CMO, and the implementation of increased market access under several FTAs by the USA? What will the situation on the EU market be? Which internal price will prevail? Which of the current and future preferential exporters will still be present on the market and what will be the overall amount of imports? What will be the overall amount of domestic production in the EU and what will be the shares of individual member states? How much will sectors which are affected by preference erosion shrink and what will be the new destinations of exports of former preferential suppliers?

- How will the potential further steps of unilateral or multilateral liberalization affect these outcomes? What will, for instance, the effects of a possible WTO agreement be? What will be the effects of a liberalization of the policies of the EU alone? How will the world sugar market look like if all global distorting policies are abolished?

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[6] A selection of these will be surveyed in this study.

The study is structured as follows: In chapter two, the world sugar market is described qualitatively and quantitatively. A special focus is put on the elaboration of properties which distinguish it from the markets for other agricultural commodities. The sugar markets and policies of thirteen major players are reviewed. With this information, the second part of the chapter discusses what preferable and necessary features of an equilibrium model-based analysis of the world sugar market would be. Chapter three provides a rough classification of equilibrium models which have been used to analyze the world sugar market before and reviews the structure and results of some model-based studies published in recent years. In the fourth chapter, the analysis with the SPE is intensively discussed by first giving an introduction of the underlying theory, then describing the methodological structure and empirical base of the SPE model used in this study, and finally describing and interpreting projections for different policy scenarios simulated with the model. Chapter five summarizes the core results and draws some conclusions. Finally, weaknesses and drawbacks of the SPE method are discussed and an outlook is given about how the analysis can be improved in future studies.[7]

[7] Throughout the whole text, the word ‘chapter’ refers to the highest level of outline structuring of the text. The word ‘section’ refers to all lower levels.

2 The World Sugar Market and its Peculiarities

2.1 Overview and Characteristics of the World Sugar Market

2.1.1 The Global Sugar Production and Markets

2.1.1.1 Sugar Production

Sugar is, like cereals and oilseeds, a tradable agricultural commodity. There are, however, a number of factors by which the world sugar market differs from the markets for other agricultural products. In this chapter the global sugar market is described and the characteristics which distinguish it from markets for other agricultural products are explained.

Sugar is, unlike for instance cereals, not a crop, but a processed product. It is produced chiefly from two crops which are sugar beet and sugar cane. Sugarcane accounts for around 74% of the sugar produced globally, the remainder coming from sugar beet. Figure 2.1 shows the global distribution of beet and cane production. Sugar beet is grown in temperate regions such as Europe and North America. The only country in the southern hemisphere with a sizeable beet production is Chile. Sugar cane is cultivated in tropical and subtropical regions. This regional distribution leads to sugarcane being produced mostly in developing countries and sugar beet mainly in industrialized countries (Illovo, 2006). Another consequence of that geographical distribution is that beet sugar is usually protected and subsidized by the governments of beet producing countries whereas cane sugar is often competing without any such measures. The level of producer support for sugar in industrialized countries is, however, usually considerably higher than it is for other crop products like, for instance, cereals (Mitchell, 2004)(see also section 2.1.2).[8]

[8] Cereals in the European Union are currently protected at a level which, if at all, only marginally exceeds world market level, while sugar even after full implementation of the 2006 reform is still protected at a level of double the world market price. Before the EU embarked on its first major reform of its agricultural policies in 1992 the protection level of cereals was about 50% above world market prices whereas that for sugar was three times the world market price.

Figure 2-1: Map of Sugar Beet and Cane Production Areas

Source: Illovo (2006); own adjustments.

The first step of processing is closely linked to the place of agricultural production since both crops are highly perishable and the transportation costs are high. Cane juice is usually first processed to raw sugar which contains a certain share of molasses giving it a brown colour and a different taste. In a second stage, usually in a different factory, it is further processed to white sugar, which is referred to as refining.[9] Beet juice, on the other hand, is always processed to white sugar in the factory. This difference in the production process has several reasons. First, beet molasses has an unpleasant taste for which reason raw beet sugar is not suitable for human consumption. Furthermore is the process to refine beet juice directly into white sugar more efficient than a two stage process. Cane molasses, on the other hand, has a pleasant taste. Thus, cane sugar can be consumed in the raw stage.[10] Furthermore, the two stage process is more efficient for cane sugar, since the direct refining of cane juice is more expensive than that of beet juice (Mitchell, 2004). In addition, transportation of raw sugar is much cheaper than that of white sugar, which makes it advantageous to carry out the refining close to the point of final consumption ((ISO, various years), see also section 2.1.1.4).[11] To escape the high cost of refining raw sugar into white sugar, in many developing countries less costly refining technologies are employed producing lower qualities of refined sugar referred to e.g. as “plantation white” or “mill white” (Mitchell, 2004). This makes it sometimes difficult to compare prices and production costs among different countries and qualities.

2.1.1.2 Supply, Demand, Trade and Prices

Table 2-1 shows the sugar balances of the most important countries in terms of production consumption and trade. Global sugar production in the years from 2003/04 to 2006/07 was 138 million metric tons WSE. The top five producers are Brazil, the European Union, India, China and the United States, accounting for 58% of global production. The same countries though in a different order are the world’s largest consumers of sugar. The most important net exporters are Brazil, Australia, Thailand, Guatemala and the EU, Brazil’s exports being much larger than those of all the rest. The biggest importers are Russia, the USA, Indonesia, Japan and India.

[9] The white sugar yield of raw sugar is generally stated with 92%.
[10] The raw sugar available in retail stores in industrialized countries, however, is for hygienic reasons, usually refined sugar to which cane molasses is added.
[11] A numerical example shall be shown in section 4.1.2.2.5.

Table 2-1: Sugar Balances of Selected Countries in Thousand Tons WSE, Average from 2003/04 – 2006/07 [a]

	Supply		Demand		Net Exports
Brazil	27,499	(20%)	9,813	(7%)	17,685
EU-25	18,507	(13%)	17,243	(13%)	1,264
India	17,244	(13%)	18,547	(14%)	-1,303
China	9,770	(7%)	10,777	(8%)	-1,008
USA	6,786	(5%)	8,555	(6%)	-1,769
Thailand	5,669	(4%)	2,110	(2%)	3,559
Australia	5,001	(4%)	1,100	(1%)	3,901
Russia	2,494	(2%)	5,879	(4%)	-3,385
Indonesia	2,156	(2%)	3,806	(3%)	-1,650
Guatemala	1,888	(1%)	595	(0%)	1,293
Japan	852	(1%)	2,171	(2%)	-1,318
Others	39,837	(29%)	53,112	(40%)	-13,276
Total	137,702		133,708		

Source: F.O. Licht(2007), own calculations; a Numbers in brackets are percentages of global values.

The prices for sugar are somewhat volatile as it is the case for many agricultural products, whose consumption levels are quite stable, but whose production is dependant on annually changing weather conditions. The complete isolation of some large countries' sugar markets from world market price signals may have increased this volatility. Figure 2-2 in the next section shows the development of the world market price of sugar (raw, fob) in the last decade. On average it has been slightly below US$ 200 per ton. In February 2006, however, it rose to US$ 425 (see next section), whereas in May 1999 it faced a low of US$ 104.

2.1.1.3 Markets connected closely to the sugar market

The substitutes for sugar in consumption can be broadly categorized in caloric and non caloric sweeteners. The most important of the caloric sweeteners is high fructose corn syrup (HFCS)[12] which is produced from Maize starch. The production costs of HFCS are competitive with sugar produced by the major exporters if Maize is available at average world market prices and economies of scale are sufficiently exploited and the substitution possibilities are excellent in a number of applications, the most important being the production of soft drinks. This has led to the market share of HFCS almost reaching that of sugar in the United States by 2000. The USA remains, however, the only country where HFCS and other starch based sweeteners could capture a considerable market share. The limiting factors in other countries are high transportation costs (HFCS is liquid), limited availability of maize at low prices, inability to benefit from economies of scale and (in the EU and Japan) production quotas for HFCS (Mitchell, 2004). There are other caloric sweeteners, starch-based, such as maltodextrins and non-starch-based such as inulin syrup and sugar alcohols/ polyols, which are, however of minor importance as sugar substitutes for several reasons. The same holds for non-caloric sweeteners (European Commission, 2004b; Van der Linde et al., 2000).

Substitutes in supply of sugar are naturally all agricultural products competing with sugar crops for land and other factors of production, but since sugar is a processed product also alternative uses of the sugar crops have to be considered. The principal alternative use for sugar crops is the production of ethanol. Ethanol can be used for several purposes, the most important being vehicle fuel. The demand for ethanol from sugar crops and other crops has proven to be able to impact agricultural world markets substantially in seasons of high oil prices. Figure 2.2 shows the co-movement of world crude oil and sugar prices in the period from 1997 to 2007. While in the first years the integration of both series seems quite loose, it becomes very tight by mid 2002. When the oil price peaked at around 70 US$ per barrel in 2006, the sugar price also rose to a high of 400 US$ per ton and above. By the end of 2006 the oil and the sugar price both had declined. Since then, however, the tight co-movement seems to have come to an end. While the sugar price continued to fall the oil price reached another peak in October 2007, even higher than that in 2006. The ability of biofuels in general and sugar cane based ethanol in particular to serve as a long-term sustainable and economically viable substitute for fossil fuels and to be an appropriate means for reducing carbon emissions is intensively debated, especially after the peak of sugar prices in 2006 and those of other agricultural commodities which in some cases still persist. To present a comprehensive overview of that discussion exceeds the scope of this study by far. It is, however, important to notice that any future analysis of the world sugar market would be incomprehensive without taking into account the effects of ethanol based processing demand for sugar crops (Bureau et al., 2007).

[12] In Europe usually referred to as Isoglucose.

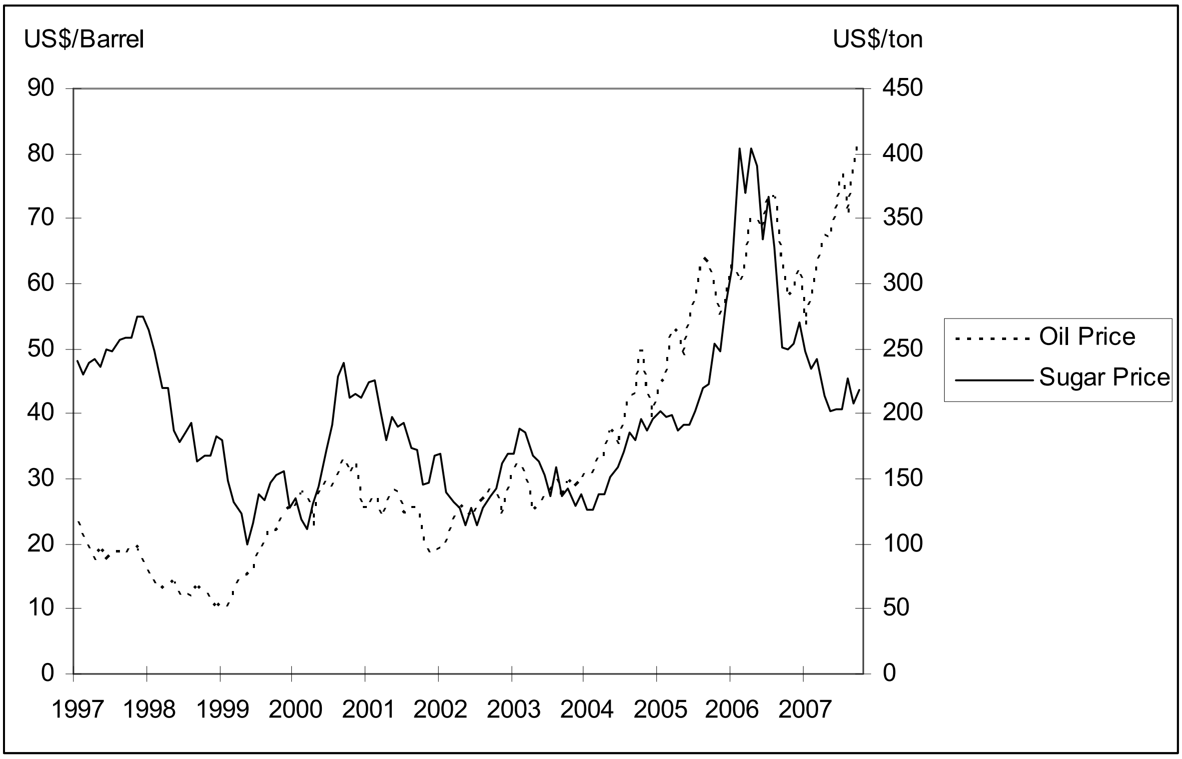

Figure 2-2: Movement of World Sugar and Crude Oil Prices [a]
Sources: EIA (2007); Intercontinental Exchange (2007); own calculations. [a] Oil price: All countries spot price fob, weighted by estimated export volume. Sugar price: No. 11 Contract (raw sugar fob), 1st nearby future contract.

2.1.1.4 Transportation Costs

Sugar is traded internationally mainly in the form of raw sugar and white sugar.[13] Most of the internationally traded sugar is transported over the ocean. Only minor distances are operated by road or rail. Raw sugar is transported in Bulk vessels. White sugar, on the other hand, is transported in 50 kg bags. Different sources contradict each other about the exact mode of transport of white sugar. While one states that the bags are loaded in a bulk vessel (House of Lords, 2005), others state that the bags are (more and more) stored in twenty foot containers (August Toepfer & Co. KG, 2006). As mentioned before, the transportation of white sugar is more expensive, which is mainly so since the loading and unloading costs are higher. White sugar has, however, only 92% of the weight of raw sugar (measured in WSE), which drives the transportation costs of white sugar down as compared to raw sugar. In total the transportation cost of white sugar including loading and unloading costs exceed those of raw sugar measured in WSE by around US$/t 25 on the route Brazil to Eastern Europe, which is equivalent to 75% (House of Lords, 2005). This leads to raw sugar

[13] Other forms of minor importance are iced sugar, sugar confectionary and, of course, products of the soft drink and candy industry. The transportation cost of those shall be neglected here although they may substantially and systematically be different from the above mentioned forms in terms of transportation costs.

shipments being the dominant form of international sugar transportation. Shipments of white sugar, though more expensive, occur if the exporting country is, as the EU a beet producer and does thus not produce raw sugar or if the importing country does not have a refining industry. The economics of raw cane sugar production together with cost advantages of some countries' refining industries lead to the interesting phenomenon of those countries being at the same time large scale importers and exporters of sugar, which they process to white sugar and re-export it to countries without a refining industry (or sufficient capacity). Examples for these countries are currently South Korea, Malaysia and the United Arab Emirates.

In the following, only transportation costs of raw sugar shall be regarded since this is the form in which the largest share of international sugar trade takes place. They will also be used as parameters in the quantitative analysis in chapter 4.

The costs of supply of raw sugar can be categorized as in table 2-2.

Table 2-2: Cost Components for the Supply of Raw Sugar

Cost position	Incoterms [a]
Production cost	exw (ex works)
+ Transportation from factory to the port	fas (free alongside ship)
+ Loading on vessel	fob (free on board)
+ Ocean transport to port of destination (fio: free in and out)	cif (cost insurance freight)
+ Unloading from vessel	cif landed
+ Transportation to buyer/wholesaler	wholesale price

Source: TIS (2007), own compilation; [a] "International Commercial Terms", published by the International Chamber of Commerce (ICC). In this table tariffs and export subsidies as well as any other measures of trade policy are ignored.

When costs of production of sugar are compared in literature, it is not always the exw-costs which are referred to. If one wanted to compare, e.g., the costs of European and Brazilian producers of sugar to supply the EU market it would make sense to compare the exw price of the European producer to the cif landed price of the Brazilian producer in a suitable European port.[14]

Transportation costs from the place of production to the next sea port can make up for a high share of the total supply costs for bulk agricultural commodities such as sugar, depending on the conditions of the rail and road network in the country in question and, of course, on the distance between the production area and the exporting port.[15] Data on internal transportation cost is hard to obtain. Indian Press (The Hindu Business Line, 2006d) quotes transport costs from southern mills to the ports with 400-700 Rupees (Rs) per ton, which is equivalent to around US$ 9-15 (OANDA, 2007). The same newspaper also reports a subsidy granted to Indian sugar exporters to cover their internal transportation expenses of about US$ 10 – 12, depending on their location (The Hindu Business Line, 2002). Statements about the transportation costs from a factory in the state of Uttar Pradesh, which is located more remote from the coast, to the port amount to as much as US$ 29 (The Hindu Business Line, 2006c). Data on inland transportation costs for raw sugar from other countries could not be retrieved from the available literature. The USDA (Salin and Faust, 2006), however, published information about costs of inland transport of Soybeans in Brazil. Soybeans can, as raw sugar, be classified as an agricultural dry bulk commodity and ocean freight rates for both are rather similar. Therefore, transport costs of soybeans from the place of production to an exporting port, can be assumed to be similar to those for raw sugar as well. The costs stated in the report range from about 13 US$ to US$ 80 per ton. For a route which is also used for sugar (Riberão Preto, SP – Santos) they amount to about US$ 24 (Average 2005).

Loading the sugar on vessels happens with grabs. It cannot be treated as suction cargo like other agribulk commodities, e.g. cereals, as the equipment would be contaminated (August Toepfer & Co. KG, 2006). Data on loading cost is very rare. The only available source is an Indian newspaper article (The Hindu Business Line, 2006d) stating the costs of port handling with 300 Rs, corresponding to US$ 6-7.

Ocean freight costs for sugar are highly volatile depending on utilization of capacities on the bulk shipping market. Sugar is a price taker in the market for bulk ocean transportation, the main commodities there being iron ore, coal and cereals. Unlike the latter, sugar is

[14] Under the assumption that costs of transportation from factory to the wholesaler are more or less the same as from the port to the wholesaler

[15] For Ukrainian grains they are reported to account for up to 20-30% of the fob price (Striewe, 2006).

chiefly transported in vessels of the Handysize (10,000 – 35,000 deadweight tons (dwt)) or Handymax class (35,000 – 50,000 dwt) (Striewe, 2006). The availability of ocean freight rates for sugar is somewhat better than that for the other cost components discussed in this chapter. The ISO publishes on weekly base bulk ocean freight rates for sugar, raw and white, on major routes. The average transportation costs for raw sugar on those routes in the base period of the model to be applied in this study (2004-2005) are presented in table 2.2 below.

Table 2-3: Average Ocean Freight Rates for Raw Sugar (2004-2005) in $ per Ton Raw Sugar

	Venezuela	US Gulf	Baltic	Morocco	Egypt	Black Sea	S. China	Japan	S. Korea	Iran
Cuba	24	-	36	34	36	37	52	56	53	58
N.Brazil	23	28	32	29	31	32	49	53	50	55
Santos	25	29	34	31	33	34	49	53	50	55
Pto. Que-tzal	21	27	38	35	38	39	41	43	40	52
B'Ventura	22	27	39	36	38	39	41	44	40	52
Thailand	35	36	35	31	34	35	17	20	18	30
Durban	-	35	-	31	35	36	34	37	36	33

Source: ISO (various years); own calculations. Santos: South Brazilian Port, Puerto Quetzal: Guatemalan Pacific Coast; Buenaventura: Columbian Pacific Coast; Durban: South African Port.

For unloading a vessel the same applies as for loading. There is, in fact, no reason to believe that the costs for both are - ceteris paribus - significantly different from each other. Different sources state the unloading costs per ton of raw sugar with US$ 7 (House of Lords, 2005) in an industrialized country as the UK and with US$ 10 (The Hindu Business Line, 2006a) in a developing country such as India. Port handling charges depend to a high degree not only on infrastructure, but also on labour costs and administrative regulations. They might, therefore differ significantly among developing countries and might also be below those in industrialized countries in some cases (August Toepfer & Co. KG, 2006).

Transportation costs from the port to the wholesaler or buyer are rarely cited in literature. Indian press (The Hindu Business Line, 2006b) quotes cost for unloading raw sugar from a ship and transporting it to a refinery with 800 Rs, corresponding to roughly US$ 18. Corrected for port handling charges (see previous paragraph) net transportation costs would be US$ 8. Under the assumption that transportation cost from the factory to the wholesaler match roughly those from a port to the wholesaler, one could rely on wholesale margins for standard agricultural dry bulk commodities, which are published e.g. in the documentations of agricultural sector modelling studies, such as Banse et al. (2005). The wholesale margin for cereals and oilseeds there are 6% in the EU-15 and the US and go to up to 25% in some Eastern European countries.

Of all the components of transportation costs surveyed above, ocean freight rates seem to occupy the largest share in total transportation costs. They are reported, however, only for some routes, though the most important ones in international sugar trade. Since in a spatial analysis transportation costs play a major role, and for a the model to be applied in chapter 4 a comprehensive set of transportation costs is necessary to make useful estimates of future trade flows, in the following it is attempted to provide estimates for ocean freight rates on other routes. To be able to infer from the information available by ISO information on freight rates on other routes the determinants of freight costs in the available data set are analysed. First, the distance (World News Network, 2007), the loading capacity of the port of origin (ISO, various years), and dutiable passages through the Panama Canal and Suez Canal have been identified as determinants of ocean freight rates. One further determinant is the Baltic Dry Index (BDI) which is published by Baltic Exchange Ltd. in London and captures the above mentioned fluctuations. It is calculated from dry bulk shipping rates of vessels of various size classes on 22 key routes (Baltic Exchange, 2007). If one compares the BDI to the time series for the ocean freight costs on one route, say from Brazil to the Baltic Sea, as it is done in figure 2-3, one notices that both show a high degree of co-movement.

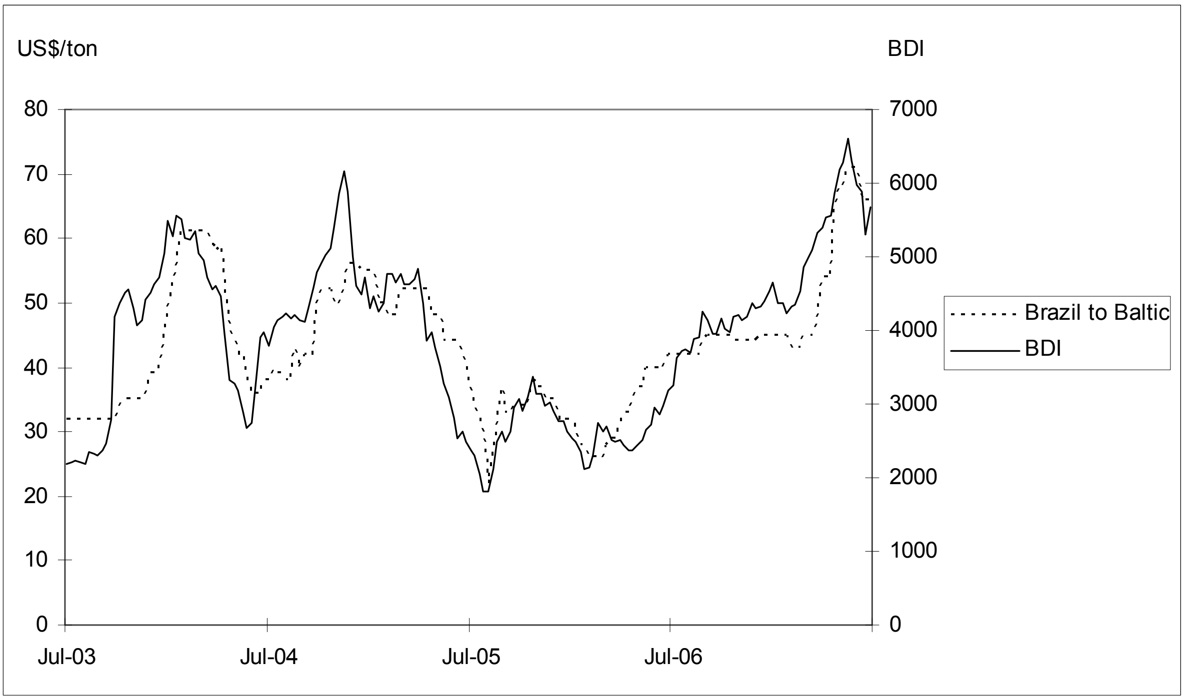

Figure 2-3: Baltic Dry Index and Freight Costs from Brazil to the Baltic Sea per Ton of Raw Sugar.

Source: ISO (various years). EuroInvestor (2007).

One caveat must be added in this context. Some ports, mostly in developing countries, are restricted to the docking of vessels below a certain size. If the demand of ocean transportation services from or to those ports increases stronger than the demand for dry bulk ocean transport as a whole, the daily charters and therefore the per ton rates on this segment may increase at a rate above the BDI (Striewe, 2006).[16]

To estimate the influence of the various determinants identified in the previous paragraph, a multiple linear regression (Ordinary Least Square (OLS)) has been performed. After the influence of the loading capacity of the originating port was found to be not significant, the variable has been deleted from the model and a regression with the reduced model has carried out.[17] The source of freight cost (ISO, various years) stated, that the reported vessels would be loaded within three to four weeks after publication of the freight costs. For that reason the same regression was undertaken again with a BDI as independent variable that was four weeks ahead of the publication date. As expected, the explanatory power could be

[16] The opposite is not true: One vessel can always be substituted by two others of half the size, but not vice versa.

[17] The calculation of the BDI includes all costs arising on the routes out of which it is calculated, also the canal passages. Given this it would make sense to employ a regression model in which all independent variables are multiplied by the BDI. Such a model, however, proved to have a smaller explanatory power than the one used here.

increased by that. The R² of the regression rose from 0.537 to 0.612. Information about developments on the dry bulk ocean freight market may not be perfectly available to all contracting parties. Thus not the exact value of the BDI at the date of loading may be the determining variable, but the broad expectations they have about it. Therefore, a five weeks moving average of the BDI was used as an explaining variable. This step again increased the R² of the regression. To investigate possible regional differences, the regression was repeated with regionalized subsets of the sample including all rates from or to single ports in the sample. In some cases, the regression resulted in negative (which is implausible) coefficients for canal passages. In those cases, the respective variables have been removed from the model and the regression was rerun.

Table 2-4: Results of Regression of Ocean Freight Rates for Raw Sugar in US$ per Ton [a]

	Full Sample		**Santos**		**Morocco**	
Constant	2.3***	(0.4)	-7.7***	(0.8)	14.1***	(0.9)
BDI	0.00598***	(0.00008)	0.00727***	(0.00015)	0.00572***	(0.00016)
Distance	0.00301***	(0.00003)	0.00372***	(0.00006)	0.00074***	(0.00011)
Panama	1.5***	(0.2)	-	-	6.3***	(0.4)
Suez	5.3***	(0.2)	15.9***	(0.5)	-	-
R^2	0.62		0.80		0.59	
F Test	4544.49 (0.000)		2310.35 (0.000)		561.34 (0.000)	
Number of Observations	11,197		1,780		1,165	

Source: ISO (various years); EuroInvestor (2007); World News Network (2007); [a] * significant at the 0.1 level, ** significant at the 0.05 level, *** significant at the 0.01 level. Numbers in brackets at the right hand side of the coefficients are the standard errors.

Table 2-4 shows the results of the regression for the whole sample and for two of the regional sub-samples.[18] Most coefficients estimated are significant at the 0.01 level, in fact all coefficients in the table above. Two points are worth discussing about the results of the table. The first is the high regional difference with regard to the influence of canal passages. This is counterintuitive, since the passage duties should be the same for any vessel of the same type and size and as pointed out above, raw sugar is mainly transported in bulk vessels of the same size class. And there seems to be, unfortunately, no apparent other explanation for the emergence of the numbers. The second is the relatively low coefficient of the distance for the freight rates to Morocco, which can also be observed for other ports in Europe and the

[18] Santos in southern Brazil and Morocco are chosen as one importing and one exporting region. The results for all regional sub-samples are listed in the Annex.

Mediterranean in the sample surveyed. A plausible explanation for this is in contrast quite easily found: The distances to all supplying ports in the sample show a lower variance than the distances from, say, South Korea to those ports. This could have lead to an underestimation of the influence of the distance in an estimation of ocean freight rates applying these coefficients.

A similar regression as the one described above is performed for all routes for which freight costs are specified explicitly by the data. Since distance and canal passages do not change on these routes, the only explaining variable in the regression was the BDI.[19] In chapter four, where the data base for the model is constructed, the coefficients which were estimated in this section are used to estimate ocean freight rates for all necessary routes in the model.

2.1.2 Sugar Markets and Policies of Major Players on the World Market

In this chapter the most important countries in terms of sugar production and consumption are described briefly in terms of their market size and the polices applied to their sugar sectors. The countries covered are the EU and the USA followed by the most important sugar exporters Brazil, Thailand, Australia, Guatemala, Cuba, Colombia and South Africa and by the most important importers Russia, China, India[20] and Japan. The order follows the size of average exports and imports and shall be maintained in chapter 4.1.2.3 where the implementation of national policies in the model is described.

2.1.2.1 European Union

Table 2-5: Sugar Balance of the EU-25 in Thousand Tons WSE

	2003/04	2004/05	2005/06	2006/07	Average
Supply	18,587.2	20,192.8	19,349.8	15,899.3	18,507.3
Demand	17,249.1	17,311.7	17,212.7	17,200.1	17,243.4
Imports [a]	1,901.9	2,169.5	2,258.2	2,340.9	2,167.6
Exports [a]	4,683.0	3,912.7	6,153.7	6,149.5	5,224.7

Source: F.O. Licht (2007), Eurostat (2007), own calculations. [a] Extra EU-25 trade recorded for calendar years 2003 till 2006.

[19] For results refer to the Annex tables

[20] India's net trade position changes from year to year and trade is tightly controlled by government agencies. At average world market prices, however, India is not a competitive exporter and is thus listed here among the importing countries (USDA 2007, *GAIN Report IN7035*).

The EU as the only country in the world is due to its sugar market policies at the same time as well a major exporter and importer of sugar as can be seen from table 2-5 above. The EU CMO for sugar has been reformed in 2006 (Council Regulation (EC) No 2006/318 (European Union, various issues)).[21] The old system and the basic measures of the reform is described briefly in the next paragraphs.

Under the old system the price of sugar in the EU was protected to approximately three times world market level. An intervention price for sugar and a minimum price for beets to be paid to farmers were installed as a bottom to the internal price level. The market price for sugar was, however, almost during the whole duration of the CMO considerably above those prices which was provided for by the quantity restricting instruments of the CMO. Production of sugar was limited by national quotas. These were divided into A and B quotas. The basic difference between both was the effective producer price that was paid to farmers, i.e. the price minus the levies collected. The effective producer price for B-Sugar was considerably lower than that for A-Sugar. Sugar produced in excess of the quota, so-called C-Sugar, was not subject to any producer support and had to be exported at world market prices (European Commission, 2004b).

Since tariffication of its import regimes after the UR, the EU has levied a tariff of € 419 per ton of white sugar to which an additional duty could be added depending on the level of world market prices under the special safeguard clause (SSG). Throughout the whole period since then, the EU made use of this possibility thus total border protection was around € 500 per ton at which imports were effectively prohibited. Under preferential import schemes, however, substantial quantities of sugar could enter the EU market at reduced or zero tariffs. The most important of these schemes was the sugar protocol attached to the Lomé and Cotonou treaties which provided for duty market access of 1.3 million tons (WSE) for some ACP countries and India. With the accession of Finland, the EU opened a quota (usually referred to as CXL) of roughly 85 thousand tons of raw sugar which could enter the EU market at a reduced rate of duty (€ 98 ton of raw sugar) in order to allow the former exporters to Finland to maintain their market access. Under the Balkans Initiative market access is granted to some countries, mainly Serbia, for a quantity of 0.25 million tons. In 2001 the EU started the EBA Initiative for LDCs with a quota for duty free sugar imports from LDCs gradually increasing from 74 thousand tons (WSE) in 2001/02 by 15% annually until in 2009/10 all import duties and quantity restrictions are removed. Finally, there are prefer-

[21] Council Regulation (EC) 318/2006 (OJ L58, 20.02.2006, pp. 1-31).

ential imports under the SPS (Special Preferential Sugar) regime. These imports serve the purpose to ensure the refineries in the EU can utilize their full capacity, by sufficient availability of raw sugar. The amount of raw sugar imported under SPS is the balance of the refineries capacity and the raw sugar which is produced in the French Overseas Departments and which enters the EU market under the preferential schemes mentioned above. This quantity is usually around 0.2 million tons, which is distributed between ACP countries and India. With increasing quantities of sugar imported under EBA, the SPS quantities will, however, decrease (European Commission, 2004b).

With quota production and preferential imports the community market would be oversupplied at a price of € 700 per ton. To balance the market a sizeable share of the EU sugar production is exported with subsidies to fill the gap between the community price and the fob world market price.[22] Since the quantity and volume of subsidized exports is limited by the URAA a certain share of A- and B-sugar can be declared as C-sugar which has to be exported without refunds, which is called reclassification (European Commission, 2004b).

Multiple forces putting pressure on the EU sugar sector lead finally to a reform in 2006. Next to internal forces such as consumers and processors of sugar suffering from the old system the external pressures were the dominating ones. The first major external factor were the imports expected to enter the EU after the phasing in of full market access for LDCs under EBA from 2009/10 onwards. Various sources give numbers for expected imports in a range between 2 and 3 million tons (BUREAU ET AL., 2007; FISCHER-BOEL, 2005, MITCHELL, 2004).[23] Those quantities would have to be re-exported with subsidies to sustain a balanced EU market which would have required additional funds from the EU budget and would have brought the EU into conflict with its limit on export subsidies. The second major external issue was the decision of the WTO Appellate Body over a complaint by Thailand, Australia and Brazil that the EU would exceed its export subsidy limit by exports of C-sugar which was considered cross-subsidized on the one hand and by the re-exports of ACP sugar on the other hand. In the view of the EU both amounts were considered unsubsidized. The Appellate Body, however, supported the view of the complainants (European Commission, 2006).

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[22] The quantity for which export subsidies were actually paid is only 1.3 millions tons plus another 1.3 million tons of ACP re-exports. Additionally, some 3 million tons were exported without receiving subsidies (see export data in table 2-5), so called C-sugar. However, the latter was considered cross-subsidized by a WTO panel (see next paragraph).

[23] Much lower Figures are stated by Van Berkum et al. (2005).

The reform, which was finally decided upon in 2006, introduced some major changes to the system the most important of which are described in the following paragraph.[24] The A and B quota are merged into one quota, whose overall level was left unchanged. Former C-Sugar producers were even given the possibility to purchase an overall amount of 1.1 million tons of sugar quota within national limits. The production of sugar in excess of the quota, formerly C-Sugar, will be, though not forbidden, effectively prohibited by a surplus amount levied on such sugar and a carry forward mechanism which allows companies to declare sugar as being produced in the following marketing year. The intervention price system is replaced by a reference price system. The reference price will gradually decrease by 36% from € 631.90 per ton (WSE) to € 404.40 (European Commission, 2006)(Council Regulation (EC) No 2006/318). Once the reference price is undercut, a private storage scheme is triggered. The minimum beet price for farmers is cut over four years by 42% to a final level of € 26.29 per ton. The price decrease for farmers is partially compensated by a direct payment covering 64.2 % of the price cut. This payment is to become part of the single payment scheme. As mentioned above there are no mandatory quota cuts. The necessary reduction of quotas is to be achieved by the installation of a restructuring fund to which producers can sell quotas (European Commission, 2006). The amount they receive will be gradually reduced from € 730 to € 525 per ton of quota in 2009/10 (European Commission, 2006)(Council Regulation (EC) No 2006/318).

By May 2007 a net of slightly more than one million tons of quota had been sold to the restructuring fund.[25] Eventually however, a reduction in the order of 6 million tons must be achieved even without accounting for additional future imports from EBA or Economic Partnership Agreements (EPA) negotiated currently with ACP countries. Only three countries, Slovenia, Ireland and Latvia, had ceased production completely. The new CMO sugar allows the commission to cut quotas linearly in all member states if after 2010 insufficient quota has been sold to the restructuring fund, and the commissioner threatened to do so. To avoid such a step, the commission proposed some changes to the restructuring rules to ensure enough quota will be sold by 2010 (Bureau et al., 2007). At the moment it is, however, not possible to estimate whether that will be sufficient to achieve a balanced EU market by 2009/10.

[24] For a more detailed description the reader is referred to European Commission (2006), Bureau et al. (2007), and Council Regulation (EC) No 2006/318 (OJ L58, 28.02.2006, pp.1-31).

[25] This means quota sold to the fund minus quota bought by formerly C-sugar producing enterprises.

2.1.2.2 USA

Table 2-6: Sugar Balance of the USA in Thousand Tons WSE

	2003/04	2004/05	2005/06	2006/07	Average
Supply	7,219.0	6,573.5	6,176.4	7,176.0	6,786.2
Demand	8,231.2	8,526.0	8,699.5	8,762.1	8,554.7
Imports	1,413.6	1,676.7	2,913.4	1,656.0	1,914.9
Exports	122.1	196.2	181.5	248.4	187.1

Source: F.O. Licht (2007), own calculations.

The sugar market of the USA is on of the biggest in terms of production as well as consumption. Table 2-6 shows that average annual production and consumption in the period from 2003/04 to 2006/07 were 6.8 and 8.6 million tons WSE, respectively, which makes it the fifth largest consumer and producer of sugar in the world. The USA produces sugar from both beet and cane on a large scale. Like the EU, the US has a protected sugar market which provides a sizable profit margin to domestic producers and preferential importers. In contrast to the EU, sugar exports only take place on a minor scale and without subsidies.

The basic tool to provide price support to US sugar farmers are nonrecourse loans. These are granted to processors of sugar per quantity of production provided they pay a minimum price for beet and cane to farmers. The loans being nonrecourse means the USDA has to accept sugar instead of repayment of the loans. This way an effective minimum price is established. To avoid such forfeitures[26] of sugar which pose a burden to the federal budget, the USDA has several possibilities to limit the market availability of sugar and by that to increase the domestic price of sugar to a level at which forfeitures are discouraged. The most important of those is the installation of marketing allotments for sugar producers based on past production. The overall allotment quantity determined each year is divided between cane and beet processors at fixed proportions, the former receiving 45.65% and the latter 54.35%.

The USA has several schemes under which preferential imports of sugar take place. The most important in terms of quantity is the raw sugar TRQ which is distributed to 40 countries. The largest shares of quota are held by Brazil, the Dominican Republic and the Philippines. The raw sugar TRQ is not fixed but can be adjusted to meet the requirements of the market. The minimum national quantity which cannot be undercut by a downward adjustment of the TRQ is a so-called minimum boatload of 7,258 tons raw value (= 8000 short

[26] To forfeit sugar means to deliver sugar to government agencies instead of repaying the loan.

tons). Imports inside the raw sugar TRQ and a small refined sugar TRQ on average amounted to roughly 1.1 million tons in recent years. Besides those TRQs there are provisions of market access for Mexican sugar under NAFTA and for some Central American countries and the Dominican Republic under CAFTA-DR. NAFTA came into effect in 1994 with market access for Mexican sugar to the US gradually increasing until it is unrestricted from 2008 onwards (USDA, 2006). There is lots of concern about NAFTA market access for Mexico threatening the balance of the US sugar market. However, Mexico's sugar surplus is relatively small and protection of the domestic sugar market and, thus, prices are rather higher in Mexico than in the USA. (USDA, various years)(*GAIN Report MX 7031*). CAFTA-DR provides TRQs to six countries which will increase gradually over a 15 year period from 107,000 tons (raw value) to 151,140 tons. The annual growth rate thereafter will be 2,460 tons (Kennedy and Dufour, 2007). In previous years, the raw sugar TRQ was adjusted (mostly downwards) when necessary to balance US demand and supply at the desired price level. It can, therefore, be assumed, that it will be adjusted further downwards at the same rate at which NAFTA and CAFTA-DR imports are increasing. FAPRI (Food and Agricultural Policy Research Institute) projections for the next decade (FAPRI, 2006) do not show a significant change in overall imports in the USA which supports that assumption. Imports of sugar can also enter the US market duty-free under two re-export programs which ensure that an equivalent amount of sugar is re-exported to the world market either as refined sugar or in sugar containing products (USDA, 2006).

2.1.2.3 Brazil

Table 2-7: Sugar Balance of Brazil in Thousand Tons WSE

	2003/04	2004/05	2005/06	2006/07	Average
Supply	24,049.5	25,514.7	30,026.0	30,404.4	27,498.7
Demand	9,643.7	9,763.3	9,843.9	10,002.2	9,813.3
Imports	-	-	-	-	-
Exports	14,698.9	17,620.5	15,516.8	18,514.9	16,587.8

Source: F.O. Licht (2007), own calculations.

Table 2-7 shows the Brazilian sugar balance in the years from 2003/04 to 2006/07. Brazil is the world's largest sugar producer and exporter the fourth largest consumer and is one of the world's most efficient producers. Production was on average 26.5 million tons and consumption 9.8 million tons WSE. Both show an increasing tendency, the production much stronger than consumption, though. The strong increasing trend in production and hence exports is persistent, in the last decade the country more than doubled its sugar output (FAPRI, 2006). Brazil levies an ad valorem tariff of 17.5% on imports from non MERCOSUR (Mercado Común del Sur, Southern Common Market) countries, which however does not have any effect as Brazil does not import sugar and would not do so even in absence of the tariff (Elobeid and Beghin, 2005). Sugar is entirely produced from cane which is concentrated in two regions, Centre-South and Northeast. Production is less efficient in the Northeast region. The government supports producers in the Northeast by allocating the US raw quota entirely to that region and by a small subsidy (Elobeid and Beghin, 2005; Mitchell, 2004).

The Brazilian Government has been operating a biofuel policy since the 1970's when crude oil prices showed a historical peak. The most important instruments of this policy are tax exemptions and direct subsidies for ethanol produced from sugar cane and a variable mandatory share of gasoline to be blended with gasoline sold in Brazil. This policy can strongly influence the amount of sugar cane directed to ethanol production and thereby the availability of Brazilian sugar on the world markets. On average half of the annual cane harvest is processed to ethanol the other half being used for the production of sugar (Mitchell, 2004).

2.1.2.4 Australia

Table 2-8: Sugar Balance of Australia in Thousand Tons WSE

	2003/04	2004/05	2005/06	2006/07	Average
Supply	5,349.9	4,145.9	5,758.8	4,749.8	5,001.1
Demand	1,102.3	1,094.8	1,097.7	1,106.9	1,100.4
Imports	8.8	8.9	5.6	3.5	6.7
Exports	3,537.5	3,956.1	3,850.1	3,456.4	3,700.0

Source: F.O. Licht (2007), own calculations.

Table 2-8 shows that Australia's sugar production in the period from 2003/04 to 2006/07 was on average about five million tons WSE with quite some fluctuations and its demand in the same period was around 1.1 million tons. Australia is with 3.7 million tons the world's second largest exporter of sugar. Policies regulating the sugar market have been abolished in the past decades (Elobeid and Beghin, 2005).

2.1.2.5 Thailand

Table 2-9: Sugar Balance of Thailand in Thousand Tons WSE

	2003/04	2004/05	2005/06	2006/07	Average
Supply	6,698.8	4,990.5	4,673.6	6,311.2	5,668.5
Demand	2,054.4	1,969.2	2,141.0	2,275.5	2,110.0
Imports	0.0	0.0	0.0	0.0	0.0
Exports	4,700.2	3,117.4	1,957.9	3,058.4	3,208.5

Source: F.O. Licht (2007), own calculations.

Thailand is with around 3.2 million tons in the years from 2003/04 to 2006/07 as shown in table 2-9 one of the world's leading exporters of sugar and is a competitive actor on world markets. Production and thus exports underlie strong fluctuations. Production averaged on 5.7 million tons WSE and consumption on 2.1 million tons in that period. Despite its competitiveness, the Government of Thailand protects the sector by import quotas and tariffs, 65% ad valorem for in-quota imports, 99% for above quota imports (Elobeid and Beghin, 2005). The government operates a quota system which regulates which sugar may be sold on the internal market (Quota A) and under long-term export contracts (Quota B). The restriction of quota A together with the import policies lifts the Thai price level for sugar over world market prices (USDA, 2005; *GAIN Report TH 5035*).

2.1.2.6 Guatemala

Table 2-10: Sugar Balance of Guatemala in thousand tons WSE

	2003/04	2004/05	2005/06	2006/07	Average
Supply	1,835.6	1,935.1	1,754.4	2,027.7	1,888.2
Demand	535.4	592.1	624.5	627.1	594.8
Imports	15.9	10.6	7.6	7.4	10.4
Exports	1,387.5	1,015.0	1,427.8	1,132.6	1,240.8

Source: F.O. Licht (2007), own calculations.

Table 2-10 shows the sugar balance of Guatemala in the period from 2003/04 to 2006/07. Production was on average 1.9 million tons with an increasing trend and minor fluctuations. Average demand was 0.6 million tons. Guatemala is currently (2007) the world's fifth largest exporter of sugar, the main destinations being North America and East Asia (USDA, 2007; *GAIN Report GT7006*). Guatemalan imports are negligible. MFN ad valorem tariffs are 20%. Imports are duty free for members of the Central American Common Market (United Nations Conference on Trade and Development (UNCTAD, 2007)).

2.1.2.7 Cuba

Table 2-11: Sugar Balance of Cuba in Thousand Tons WSE

	2003/04	2004/05	2005/06	2006/07	Average
Supply	2,318.4	1,301.8	1,200.6	1,380.0	1,550.2
Demand	625.6	630.2	639.4	642.2	634.3
Imports	170.2	193.2	248.4	161.0	193.2
Exports	1,786.6	707.9	782.0	901.6	1,044.5

Source: F.O. Licht (2007), own calculations.

Cuba used to be the world's leading exporter of sugar for many decades. Exports mainly were shipped to the former Soviet Union in exchange for oil. The conditions of this trade were highly favourable for Cuba. When the Soviet Union collapsed the guaranteed profitable market access also disappeared and Cuba found itself with a highly inefficient sugar industry. The production fell dramatically from about 7 to 8 million tons in the late 1980s to about 3.5 million tons (raw value) in the 1990s (Mattson and Koo, 2003). In 2002 the state-run sugar industry embarked on a major restructuring process. 71 out of 156 sugar mills were closed and production again fell sharply (Hagelberg and Alvarez, 2006). This was attributed to bad weather conditions initially, but the production did not recover in the following years and remained at a level of 1.3 to 1.5 million tons (see table 2-11 Despite high sugar production costs, Cuba continues to export significant quantities of sugar. While lacking an economic rationale, this can is attributed to a longstanding trade agreement with China where the highest share of Cuba's exports is shipped to (USDA, 2007, *GAIN Report CH7029*) and external debt to Russia which is to be paid in goods (Library of Congress, 2006). It remains open whether the restructuring will eventually lead to a competitive sugar sector.

Domestic demand is subsidized by the Government under a rationing system. A monthly quantity of 6 pounds per capita can be purchased at US$ 0.13 per pound (~ € 0.38 per kg, Elobeid and Beghin, 2005) To cover domestic demand and export obligations Cuba turned to importing substantial quantities of sugar after 2002 which in the period from 2003/04 to 2006/07 amounted to 30% of domestic consumption (see table 2-11).

2.1.2.8 Colombia

Table 2-12: Sugar Balance of Colombia in Thousand Tons WSE

	2003/04	2004/05	2005/06	2006/07	Average
Supply	2,496.9	2,507.3	2,226.5	2,252.6	2,370.8
Demand	1,406.9	1,471.6	1,432.8	1,481.1	1,448.1
Imports	48.6	35.4	108.6	76.4	67.2
Exports	1,161.3	1,079.0	820.4	869.9	982.6

Source: F.O. Licht (2007), own calculations.

Columbia is major exporter of sugar. Table 2-12 shows that exports have in recent years been around 1 million tons WSE, although with a decreasing tendency. The decrease in production and, thus, exports is largely due to the increased use of sugarcane for the production of ethanol. The main destinations for exports are South and Central American countries. Columbia operates a sugar price stabilization fund. Exporting enterprises receive a payment out of the fund which is collected by a levy on domestic sales. MFN-imports of sugar into Columbia are subject to a 20% ad valorem duty. This is increased or decreased by an additional amount if the import price lies outside a price band managed by the Andean Community member states (Columbia, Ecuador, Peru and Bolivia). The floor and ceiling price for raw sugar are set to US$ 233 and US$304 per ton for the period from April 2007 to March 2008 (~ € 174 and € 227). The same system of additional duties applies for all members of the Andean Community (USDA, 2007, *GAIN Report CO7007*).

2.1.2.9 South Africa

Table 2-13: Sugar Balance of South Africa in Thousand Tons WSE

	2003/04	2004/05	2005/06	2006/07	Average
Supply	2,120.1	2,259.2	2,088.7	2,217.6	2,171.4
Demand	1,376.1	1,440.5	1,450.7	1,455.3	1,430.7
Imports	208.8	215.3	118.6	161.2	176.0
Exports	893.7	969.6	1,047.0	907.2	954.4

Source: F.O. Licht (2007), own calculations.

South Africa is among the world's major exporters of sugar. Table 2-13 shows that production in the years from 2003/04 to 2006/07 was on average 2.2 million tons WSE and consumption was 1.4 million tons. Although a major and competitive exporter, South Africa imports some 0.2 million tons of sugar, which enter the country under preferential agreements with its neighbours. Despite its competitiveness on international markets the sugar industry enjoys a high degree of protection and the internal market is highly regulated. Together with Botswana, Lesotho, Namibia and Swaziland, South Africa is member of the Southern African Customs Union (SACU) (Sandrey and Vink, 2007). The SACU imposes a tariff on sugar imports which varies with the world market price for sugar. With high world market price level in spring 2006 it was completely abolished and at the moment of writing still is. Before, i.e. from September 2005 onwards, it had been at ZAR 233 (~ € 30) per ton (USDA, 2007, *GAIN Report SF7015*). Since there was no further protection, the question arises, how the high internal price level of ZAR 3,500 (~ € 441, IBID.) ex factory can be sustained.

Domestic Marketing within the SACU is regulated by quantitative restrictions for each member country, the amounts of which are undisclosed to public. For Swaziland, the only major sugar producer in the SACU besides South Africa, this amount is estimated to be 260,000 tons (Haley and Suarez, 2003). The SACU countries are also members of the Southern African Development Community (SADC). The SADC countries among which are competitive sugar producers such as Zambia and Malawi are granted a non-reciprocal quantitatively restricted access on the SACU sugar market until in 2012 all trade in sugar is supposed to be completely liberalized.[27] The quantity of this market access is not consistently stated in literature with 20,000 tons (Sandrey and Vink, 2007) to 50,000 tons per year (USDA, 2007, *GAIN Report SF7015*). In Annex VII to the SADC Trade Protocol (SADC, 2007), the market access is linked to annual growth of the SACU sugar market, which is deemed to be 45,000 tones in the first marketing year, 91,000 tonnes in the second and 138,000 tones in the third marketing year. In the following years the market access shall be no less than those 138,000 tonnes. The treaty, however, does not specify which years are referred to by the mentioned marketing years.

2.1.2.10 Russian Federation

Table 2-14: Sugar Balance of Russia in Thousand Tons WSE

	2003/04	2004/05	2005/06	2006/07	Average
Supply	1,886.6	2,274.9	2,600.1	3,212.2	2,493.5
Demand	5,975.4	5,850.7	5,846.1	5,841.5	5,878.5
Imports	3,812.0	3,500.5	3,104.2	2,981.2	3,349.5
Exports	108.0	137.5	130.5	116.3	123.1

Source: F.O. Licht (2007), own calculations.

[27] "If the world sugar market has 'normalized' sufficiently to make such liberalization acceptable" (Sandrey and Vink, 2007).

After treating the most important exporters now the sugar sectors of the biggest importers are presented, the most important of which, in terms of import quantity, is the Russian Federation. Table 2-14 shows that Russia's imports amounted to about 3.3 million tons WSE between 2003/04 and 2006/07. The Russian sugar sector is steadily expanding with processing capacity being the key constraint. Accordingly imports are decreasing.

Russia's most important sources of sugar imports are Brazil and, though with a strongly decreasing trend, Cuba. Russia used to run a TRQ system until 2004 when it changed to a tariff-only regime (USDA, 2004, *GAIN Report RS4021*). The quotas of all in all 3.65 millions tons of raw sugar were auctioned to importing firms. The in-quota tariff used to be 15% with a minimum of € 15 per ton in 2002, the above quota tariff was 40% with a minimum of € 120 per ton for raw and € 140 per ton for white sugar (Gudoshnikov, 2001). Above-quota tariffs were not sufficient to deter imports, which is also confirmed by import data of the years before the abolishment of the TRQ system. Since 2004 Russia operates a tariff system which is designed similar to a variable levy. The tariff can be raised when the New York Board of Trade (NYBOT) fob price for raw sugar falls and falls when the price rises. However, despite strong price movements on the world market, it has been left unchanged at a level of US$ 140 per tonne since September 2005. (USDA, 2007, *GAIN Report RS7032*). The consecutive increase in the duty-paid cif import price may also have contributed to the above mentioned decrease of imports.

2.1.2.11 China

Table 2-15: Sugar Balance of China in Thousand Tons WSE

	2003/04	2004/05	2005/06	2006/07	Average
Supply	10,031.4	9,074.6	8,772.7	11,199.3	9,769.5
Demand	10,490.8	10,417.3	10,674.5	11,525.4	10,777.0
Imports	1,102.0	1,214.8	1,108.4	1,526.1	1,237.8
Exports	38.1	298.2	180.0	297.6	203.5

Source: F.O. Licht (2007), own calculations.

China's sugar market is large both in terms of consumption as in terms of production. Table 2-15 shows China's sugar balance in the period from 2003/04 to 2006/07. Production in these years was around 9.8 million tons WSE while consumption was 10.7 million tons. China is a major importer with an increasing trend. There are no recent sources available giving detailed information about the structure of the Chinese sugar industry. However, the government seems to have substantial control over the sector in terms of prices and import quantities, despite the existence of private enterprises. Nevertheless, internal prices are said to be largely determined by market forces. Still, the sector would face substantial changes if it were exposed to international competition (Mitchell, 2004).

China has a TRQ for imports of 1.95 million tons with an in-quota tariff of 15% and an out of quota tariff of 50%. 30% of the total TRQ is reserved for non-state trading enterprises. The state trading enterprises import roughly 450,000 tons of raw sugar from Cuba (see above) under a longstanding agreement (Mitchell, 2004).

2.1.2.12 India

Table 2-16: Sugar Balance of India in Thousand Tons WSE

	2003/04	2004/05	2005/06	2006/07	Average
Supply	13,557.0	12,691.0	19,267.2	23,460.0	17,243.8
Demand	17,285.0	18,584.0	18,768.0	19,550.0	18,546.7
Imports	800.4	1,968.8	36.8	13.8	705.0
Exports	450.8	72.8	1,380.0	1,288.0	797.9

Source: F.O. Licht (2007), own calculations.

India as the second largest country of the world in terms of population is also one of the biggest consumers and producers of sugar. Its integration into international trade is, however, minor. Table 2-16 shows that production is with 17.2 million tons WSE on average roughly as big as consumption with 18.5 million tons in the years 2003/04 to 2006/07. India faced severe production shortfalls in 2003/04 and 2004/05 (see table) when domestic consumption had to be fed for a large percentage from stocks.

The Indian sugar sector is tightly controlled by the government through licensing, minimum prices, stock holding requirements and transport subsidies. Furthermore, domestic processors and importers have to sell a certain share of their marketed quantities to a public distribution system at lower prices which is made available to low income consumers (Mitchell, 2004).

India whose sugar market is more or less balanced on average charges a 60% ad valorem tariff on imports plus a countervailing duty of Rs. 850 (Rs. =Indian Rupees) which is in lieu of fees on domestic sugar. The trade policy is, however, occasionally changed to deal with particularly high or low prices on the domestic or world markets. In the period of high price in 2006, for instance, the Government abolished the import duties and banned exports of sugar to keep the domestic price level low (USDA 2007, *GAIN Report IN7035*).

2.1.2.13 Japan

Table 2-17: Sugar Balance of Japan in Thousand Tons WSE

	2003/04	2004/05	2005/06	2006/07	Average
Supply	892.8	901.5	820.6	794.9	852.4
Demand	2,213.4	2,170.0	2,139.9	2,160.2	2,170.9
Imports	1,313.9	1,224.9	1,277.2	1,380.0	1,299.0
Exports	1.9	1.8	1.6	1.8	1.8

Source: F.O. Licht (2007), own calculations.

Table 2-17 shows that Japan acts on the world market for sugar as one of the major importers. The average Japanese Sugar consumption between 2003/04 and 2006/07 was roughly 2.2 million tons WSE, 1.3 million tons of which where imported. The remainder, about 900 thousand tons, is supplied from domestic production at relatively high costs. Japanese Sugar is produced from beets grown on the northern island of Hokkaido and from cane grown on the southern islands. Japans Exports are negligible.

The tariff for white sugar is prohibitive. Thus imports in Japan mainly are raw sugar. (Fukuda et al., 2002) The major suppliers are Thailand and Australia (ISO, 2007). The tariff for raw sugar has been abolished in 2000. Imports of sugar are, however, tightly controlled by Government agencies. The Ministry of Agriculture, Forestry and Fisheries (MAFF) assigns import volume targets to importing firms above which firms must pay an additional levy, letting the import volume targets effectively work like a per firm TRQ. Imports within the target volume must be sold to the Agriculture and Livestock Corporation (ALIC) and bought back at pre-determined prices (Fukuda et al., 2002). This system works effectively as an in-quota tariff would do.[28] The size of that surcharge varied in the last years between ¥ 27,000 per ton of raw sugar in 2001 (Fukuda et al., 2002) and ¥ 35,000 in 2007 (ALIC, 2007) corresponding to roughly € 250 and € 300 per ton in nominal terms. The surcharge, together with government funds, is spend to subsidize domestic processors and refiners who must purchase beet and cane from Japanese farmers at high guaranteed prices which are around ten times the world market price equivalents (MITCHELL, 2004). The subsidy allows domestically produced sugar to be competitive with imported sugar at a price level of the import price plus the surcharge, around ¥ 60,000 (€ 550) per ton in 2001 (FUKUDA ET AL., 2002) and ¥ 75,000 (€ 480) per ton in 2007 (ALIC, 2007). There is no information published, to which exporting countries the TRQs are assigned or whether they are country-specific at

[28] Regarding the compliance of such policies with WTO rules, Van der Mensbrugghe et al. (2003) state: “It is amazing that Japanese policymakers have gotten away with such lack of policy discipline until now”.

all. Sandrey and Vink (2007), however, state that such TRQs exist and accrue to South African exporters. Also an official source from Fiji states that the country has a long-term delivery agreement with Japan (Tadulala, 1998).

Surprisingly, the wholesale price for white sugar is considerably above that level. It is cited with ¥ 122,000 (€ 940) in 2003, ¥ 142,000 (€ 1010) in 2005 (USDA, 2006, *GAIN Report JA6008*), ¥ 130,600 (€ 970) in 2004 and ¥ 154,500 (€ 990) in 2007 (ALIC, 2007). The protection which is provided for refined sugar is with a tariff of ¥ 21,500 plus a surcharge of ¥ 53,880 (€ 140 + € 340, Elobeid and Beghin, 2005) per ton is not high enough to sustain that price level. Market Experts explain the difference with profit and wholesale margins between the raw sugar price and the final wholesale price for white sugar (Dyck and Fukuda, 2007).

2.2 Aspects of Modeling Sugar Markets

In this section, the aspects which play a key role for modelling the world sugar markets are discussed. In doing so, it is inevitable to talk about some common aspects of modelling in general and modelling of agricultural markets in particular. Thus, some issues which would rather fit in section 3.1 will have to be anticipated here. Throughout this section and the whole study, the term modelling refers to economic equilibrium modelling unless explicitly stated otherwise.

The internal and external policies with which a number of countries, above all the EU, govern their sugar markets lead to a situation where they are at the same time importers and exporters of sizeable quantities of sugar. To account for this fact and to simulate changes in the policy instruments which are responsible for that, it is necessary that the model is able to depict bilateral trade flows explicitly. Net trade models which depict countries as either (net-) importers or exporters of a certain commodity are unable to do so.[29]

White sugar from beets and from cane is chemically identical indistinguishable. Raw sugar, unless consumed in the raw stage[30], is an input in the production of white sugar (Mitchell, 2004). These facts justify the assumption, that sugar is a homogeneous good or a so-called fungible commodity. It is, therefore, preferable that a model to be applied for the analysis of changes in the sugar market be able to depict trade in homogeneous goods. How-

[29] Banse et al. (2005) developed a possibility to depict bilateral trade flows in a net-trade model. This approach is, however, inflexible as either imports or exports are fixed exogenously.

ever, many models of international trade employ the Armington (1969) assumption of product heterogeneity with regard to origin. This assumption leads to severe consequences when applied in the modelling of sugar markets as is discussed in Nolte (2006) and shall be described in section 3.1.

However, two issues must be discussed in the context of product homogeneity. The first is the substitutability of raw and white sugar. As mentioned above, raw sugar is for its major part an (homogeneous) input in the production of white sugar, a process which is referred to as refining. For a sugar importing country there are two possibilities to supply itself with white sugar. The first is to import white sugar directly from a beet sugar producing country or a country with a refining industry, the second is to import raw sugar and refine it in the country. Thus, for a country which in the past followed the first path, it will require the establishment of a refining industry if it were to switch to importing raw sugar in the future. On the other hand, for a country following the second path, its domestic refining industry would become idle if the country were to switch to importing white sugar. In that case it can be expected that the refining industry would consider its facilities as sunk cost and operate at variable cost until they are outdated. To substitute between raw and white sugar may hence require temporal adjustment. Furthermore, differences in efficiencies of refining industries have a significant influence on trade patterns, which is proved by the situation of countries like South Korea which import raw sugar and export refined sugar without producing sugar crops themselves. It is possible and likely that more countries specialize in refining imported raw sugar in the future, when the EU will reduce its exports of white sugar considerably. To capture the friction in the substitutability between raw and white sugar in an equilibrium model, the most exact way would be to model them as two products and to include a refining activity in the model[31]. If one wanted to account for the temporal adjustment it would also be necessary to model the refining industry as well as the sugar production dynamically rather than statically.

The second issue necessary to be discussed in the context of the assumption of homogeneity is the substitutability between cane and beet sugar. As mentioned in section 2.1.1, beet sugar is not consumed in the raw stage. For the consumption of raw sugar it is therefore necessary to obtain it from sugar cane. One the other hand, Mitchell (2004) states that raw

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[30] According to Mitchell (2004), only about 10% of global sugar is consumed in the form of raw or partially refined sugar.

sugar which is consumed in the US and other industrialized countries is, for hygienic reasons, usually white sugar to which cane molasses is added. The substitutability would be perfect in these cases, however, require the availability of cane molasses. The issue of substitutability of beet and cane sugar is of minor relevance, though. The reason for that is that in the current situation of the world sugar market beet sugar producers are in most cases less efficient than competing cane producers and will therefore most likely not increase their production and market share. A situation in which a raw sugar consumer would consider to switch from cane sugar to beet sugar is thus highly improbable to happen. The substitution will in future rather take place in the opposite direction, where substitutability is not an issue.

As pointed out in section 2.1, sugar is a close substitute in consumption for some other sweeteners, the most important of which in terms of market share being HFCS. Including that as a product in an equilibrium model would account for this relationship. The cross relationships of HFCS are, however, wide ranging. To model the supply of HFCS it would be necessary to model the supply and demand of maize which is the input for its production, and the demand for protein feeds, which Corn Gluten Feed (CGF), a by-product of HFCS production competes with. The technical as well as the empirical requirements are hence very high.

To trade sugar as well as any other commodity is costly and those costs can make up for a vital share of final costs. It is, therefore, necessary to deal with the question of how to account for those costs in a model. The ability to do so in a net-trade modelling framework is limited, since the transportation costs had to be equal on all routes a country exports to or imports from. In a spatial modelling framework where different transport costs for different routes can be specified one has to decide between modelling the transportation sector endogenously and modelling transportation costs as parameters. Since sugar is a price taker in the market of bulk transportation due to its small share, the latter option would be the path to follow in a model of the sugar market solely. If one were to model sugar in a model which contains more or possibly all sectors of the economy, as it is the case with General Equilibrium Models (GE), the better option was certainly to model the transportation sector endogenously.

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[31] To establish such a model would besides the modeling effort require also a large amount of empirical research.

As has been pointed out in section 2.1 it is necessary for an analysis of the sugar market to account for interrelationships with the energy market. There are several possibilities available to do so. The best option would be to model processing demand for sugar crops explicitly. This would, however, require the model to depict the production of sugar crops and the processing of cane or beet to sugar as two distinct activities rather than modelling the production of sugar directly as it is the case in most modelling approaches. Furthermore the modeller would have to make assumptions about the development of energy prices, especially those for crude oil, and about the substitutability or the cross-price effects of the oil price on processing demand for sugar crops.[32] An easier way is to make estimates about the future level of sugar production costs and hence supply curves, which account implicitly for the fact that the demand for the raw product (beet or cane) faces demand competition by the ethanol sector.

The Cultivation of sugar crops competes with the production of other crops for resources of agricultural enterprises, above all for land. For that reason many models which deal with the sugar market include the production of other crops and animal products. There are many well established ways to include substitutes on the production side in an agricultural equilibrium model. The limiting factors in doing so are thus usually not of technical nature. The work load that is coming along with the modelling of additional products and even more the empirical requirements are in most cases the reasons for which modellers decide not to include all competing markets in their model or to model the markets which are not of central interest at a rougher scale. Possibilities for the latter are regional or sectoral aggregation, ignoring applied policy measures, or simply choosing the supply functions and their shifters such that they implicitly account for price expectations of competing products.

As has been mentioned earlier in this section, dynamic models are better suited to capture adjustment periods than static models. The latter have merely the possibility of shaping their (supply) functions such that they account for a degree of adjustment that is regarded reasonable in the envisaged time horizon of the model. In the case of the world sugar market it is mainly the temporal adjustment of the processing capacity, sugar factories and refineries, that makes the application of a dynamic model interesting.

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[32] It is important to point out that making assumptions about the latter is indeed the only possibility. This problem cannot be solved by empirical research at this time, since there exist virtually no observations of the substitution of gasoline and ethanol purely for reasons of the price.
In a broader context, the modeler would also have to take into account the prices and cross price elasticities of other substitutes for gasoline including other bio-fuels.

A final aspect of modelling the sugar market is the selection of an appropriate functional form. The most common functional form of supply curves in agricultural equilibrium models are isoelastic ones in partial modelling frameworks or functions derived from a Constant Elasticity of Transformation (CET) production function in GE models. Both do not allow for production to end while facing a positive producer price. This is, of course, unrealistic for all products, but usually not a severe problem as long as the run of the supply curve shows the desired behaviour in the price range the modeller expects to prevail. The potential price changes on the sugar market are, however, too large for such a proceeding. If those are to be modelled it is necessary to employ supply functions which allow for a positive intercept on the price axis, i.e. simulate the production to end below a certain price. The simplest case of a function showing that property would be a linear function, which is very restrictive, though, and whose curvature contradicts observed behaviour of producers. Another, more elegant way to model sugar supply, which under certain conditions would also allow for a positive intercept on the price axis, are so-called second order flexible functional forms. For their complexity, however, they are rarely applied in agricultural equilibrium models (Grethe and Weber, 2005). A more simple way, which is chosen by Nolte and Grethe (2007) and which will also be applied in the model used for this study, is the generalization of an isoelastic function by the introduction of an additive parameter which corresponds to the price at which the production of sugar will be abandoned.

3 Modeling Approaches and Results of Former Studies

After having identified necessary and useful features of an equilibrium model of the world sugar market, existing models are reviewed in this chapter. In section 3.1 the most common modeling approaches are classified and described. In section 3.2 models which have been applied to analyze the world sugar market in the recent past shall be examined with regard to their structure and basic assumptions on the one hand and their results and how the former impact on the latter on the other hand.

3.1 Modeling Approaches

Equilibrium models are a widely applied tool in agricultural economic research.[33] They can be classified according to several characteristics. One of those is the breakdown in partial and general equilibrium models. The latter cover by nature the whole economy of the region which is the subject of research. The former group of models concentrates on selected sectors or sub-sectors of the economy. Examples for Partial Equilibrium (PE) models which have in the recent past been applied for the analysis of sugar policy scenarios are CAPRI (Common Agricultural Policy Regionalized Impact, (Britz, 2005)) and the FAPRI/CARD (Center for Agricultural and Rural Development) Model (FAPRI, 2007). The group of partial models can be further broken down into models using behavioural equations and those using programming approaches. Out of the partial equilibrium models mentioned above, the FAPRI/CARD Model uses behavioural equations, CAPRI employs a programming approach. General Equilibrium models applied recently for the analysis of the sugar market are the GTAP (Global Trade Analysis Project) Model (Hertel, 1997) and LINKAGE (Van der Mensbrugghe, 2005). Building a GE model requires (for the same detail of sectors and policies to be modelled) more empirical knowledge than building a PE model. Especially when the agricultural sector is large in terms of Gross Domestic Product (GDP) share and employment it is, however, useful to account for interdependencies of the agricultural sector with other sectors of the economy, factor markets and macroeconomic variables.

A second characteristic according to which models can be grouped is the ability to explicitly account for temporal frictions in the adjustment of economic behaviour as response to policy changes or autonomous changes of economic variables. Models which ignore this friction or account for it merely implicitly (by choosing parameters and functional forms in

[33] Other models applied in agricultural economic research are econometric models, which shall, however, not be discussed here.

line with the projection horizon of the model) are called static or more often comparative-static. Models which are able to explicitly depict adjustment periods on the other hand are called dynamic or recursive dynamic. The term recursive refers to the fact, that results of former periods impact on results of the current period. Of the models mentioned above, the standard version of GTAP is comparative static, the remainder being dynamic.

A third characteristic to classify models which is particularly relevant in the case of modelling the sugar market is the way in which foreign trade is modelled. A first level of classification is that between net-trade models and spatial models. In net-trade frameworks, a country is, unless it is self-sufficient, either an importer or an exporter of a certain product, depending on the world market price and the trade policies applied by that country. In a spatial model allowing for the explicit depiction of bilateral trade flows countries can be exporters and importers of the same product at the same time. For a detailed analysis of the world sugar market this feature is crucial, since their trade policies lead a number of countries, in particular the European Union, to such a situation.

The most widely applied approach to modelling bilateral trade is the so-called Armington Approach (Armington, 1969), which is applied in virtually all GE models and also in some partial equilibrium models, the majority of which, at least where the ones mentioned in this chapter are concerned, are net-trade models, though. The only partial model in the list which applies the Armington Approach and at the same time the only spatial partial model is CAPRI. The Armington Assumption underlying the approach is that products of the same kind coming from different regions or countries are imperfect substitutes (= heterogeneity with regard to origin) and the way this assumption is implemented in equilibrium models leads to some undesired, and in the case of sugar severe, consequences. The most well known of these is the so-called 4S property („small shares stay small“, also referred to as the „small shares problem“).34 An alternative possibility to depict bilateral trade flows in equilibrium models is the SPE framework (Takayama and Judge, 1971). However, neither of the models surveyed in this section applies this approach. Nolte (2006) applied the approach in a small model of the world sugar market and showed that the problems of the Armington Approach can be overcome such.[35] There are, of course, a number of other features by which

[34] See Nolte (2006) who surveys and discusses the drawbacks of the Armington Assumption and its implications for depicting the sugar market extensively.
[35] The model used for that study is the base for the model applied in chapter 4. We shall see, however, that the approach comes along with some adverse features, which the Armington Approach does not have.

equilibrium models can be classified, which are, however, of minor importance in this context.

3.2 Review and Discussion of Selected Model-Based Analyses

In this section some models which have been applied in the recent past to analyze the world sugar market are reviewed. First they are introduced and classified according to the characteristics identified in section 3.1. Then their scenarios and results are reviewed and where possible traced back to their characteristics and assumptions.

Table 3-1: Classification of Models Analyzing the Sugar Market

Study	**Model**	**PE/GE**	**Trade Formulation**	**Dynamic/ Static**	**Sectoral Coverage**	**Regional Coverage**	**Coverage of the Sugar Sector** [b]
Van der Mensbrugghe et al. (2003)	Linkage	GE	1. Gross, Armington 2. Net-Trade, Homogeneous Goods	Dynamic	22 Sectors	Global, 16 Regions	One Sector
Elbehri et al. (2000)	GTAP (Version 4)	GE	Gross, Armington	Static	13 (tradable) sectors, incl. 8 agricultural	Global, 20 Regions	One Sector (Not explicitly specified)
Van Berkum et al. (2005)	GULA	GE	Gross, Armington	Dynamic	7 Agricultural, 1 non Agricultural	Global, 12 Regions	Crops, processing
Bureau et al. (2007)	GOAL	GE	Net-trade	Static	75 products (47 agricultural)	Global, (Number of regions not specified)	Crops, processing sector, raw & white sugar
Elobeid and Beghin (2005)	CARD International Sugar Model	PE	Net-trade	Dynamic	Cross price effects for wheat, rice and soybeans	Global, 29 Regions	One Sector (raw equivalents)
Beghin et al. (2003)	"				Sweetener sectors only	Global, (Number of regions not specified) [a]	Crops, raw & white sugar, Maize & HFCS
Adenäuer et al.(2004)	CAPRI	PE	Gross, Armington	Dynamic	30 crop, 15 animal activities	Global, 13 Regions + EU 15	Sugar beet/ white sugar [c]

Sources: as stated in the first column, own compilation. [a] According to FAO (2005), 29 regions (as is stated for the FAPRI model in Elobeid and Beghin (2005)). [b] In the Last column of table 3.1 the coverage of the sugar sector is specified. The standard procedure applied by most models is to combine the cropping and the processing sector in the model and not to distinguish between raw and white sugar. This is referred to in the table as "One sector". [c] For the EU 15 sugar beet are modeled and the processing industry is accounted for by passing through a constant share of their revenues to the farmer. The market module depicts the supply demand and trade of processed (white) sugar.

Table 3.1 lists the model studies which are surveyed in this section and states the major characteristics of the models applied. The first is Van der Mensbrugghe et al. (2003). The study uses the Linkage GE model, which is maintained and applied by the World Bank, for its analysis of several sugar policy scenarios. Those are a baseline scenario with the continuation of policies that prevailed in the year 2000, i.e. after full implementation of the Uruguay Round (UR) commitments by industrialized countries and several unilateral liberalization scenarios of the EU, the US and Japan, simulating increases in their TRQs and their above quota tariffs and combinations thereof. Also two multilateral liberalization scenarios are simulated, with one assuming full liberalization by all countries. The study involves a methodological advance, which is their way of implementing TRQs in GE models using MCP (Mixed Complementarity Problem) formulation.[36] The main results and conclusions of the study can be summarized as follows. TRQ increases are found to have a much stronger effect on trade expansion of the EU, the US and Japan than moderate out of quota tariff decreases have. TRQ expansion leads to an increase in imports mainly from those countries which had a large TRQ in the baseline. Full multilateral liberalization on the other hand results mostly in increasing exports of current low cost producers. Since the standard version of the model applied by Van der Mensbrugghe et al. (2003) relies on the Armington assumption, it is difficult to specify what happens to the world market price, because in such a model only bilateral import and export prices exist. In the full liberalization scenario those (precisely the country averages) increase for most countries in a range from 7% to up to 37%, the average being about 15%. In the case of central and Eastern Europe the average price decreases.

The last scenario (full liberalization) is also calculated with a homogeneous goods (net-trade) version of the model in which all trade distortions are accounted for by ad valorem equivalents. In such a model it is possible to state a world market price, which increases by 21% in case of liberalization. Other results (production, consumption, trade welfare) move, except for the case of SACU, in the same direction as they did in the Armington version. They are, however, more pronounced.

The model in its Armington version is unable to let competitive producers capture market shares in countries in which they have not formerly been present as TRQ holders. This severe drawback is well known by modelers and also discussed by the authors. The net-trade model they construct does away with the Armington assumption and allows for more

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[36] For a detailed explanation of MCP see section 4.1.1

realistic increases of exports of those countries. It is, however, unable to specify the directions in which this expansion takes place.

Another CGE analysis had been carried out a few years earlier by Elbehri et al. (2000), calculating similar scenarios as Van der Mensbrugghe et al, i.e. 33% TRQ expansions and out of quota tariff cuts of the same size for the EU and the USA, not for Japan, though. Elbehri et al. did also not simulate a full liberalization scenario and they applied a different approach than that of Van der Mensbrugghe et al. to implement TRQs in a CGE. They use the database version 4 of the GTAP model for their calculations. The authors do not publish results of prices and, as is very common among CGE studies, they publish there results in values rather than quantities, which makes it difficult to compare them to the other studies surveyed in this section. The most far-reaching liberalization scenario they simulate is a global 33% tariff cut and TRQ expansion.[37] EU imports increase by US$ 444 million in that case, those of the USA by US$ 220 million. Sugar production decreases by 2.4% and 2.9% respectively. Global trade increases by more than US$ 2 billion. Surprisingly, Brazilian exports increase only slightly, by US$ 33 million, or 1.1%, while especially African countries other than South Africa can expand their exports considerably by almost US$ 400 million. Unfortunately, the detail in which the results and the base data of the model are published in the study does not allow relating them to the features of the model.[38] The strong increase of African exports is most probably a result of the market shares they already have in the EU and to a smaller degree also in the US. The small increase in Brazilian exports can in turn be explained by its small base share in these markets. However, the total increase in Brazilian exports is hardly more than an extrapolation of the base share of 10% which it has in US imports. Middle East and northern African countries which increase their imports by US$ 274 million would in that case have to be importing all this increase from other regions although the current Brazilian market share in this region is considerable and should be so in the base situation of the model.

Another more recent CGE study has been carried out by Van Berkum et al. (2005) using the GULA model, a model focused on the sugar market which was developed out of the standard version of GTAP (Version 6). The study simulates the medium term effects of a full implementation of EBA market access of LDCs to the EU market, first under the assumption

[37] The study does not state the year of projection.

[38] This is not only a problem of that particular study, but a common problem of model-based studies (and probably any complex quantitative analysis). This leads also to difficulties when comparing models and their results with each other.

of a continuation of 2005 EU sugar policies and afterwards assuming the implementation of the Fischler proposal for a sugar market reform from 2004.[39] Their benchmark is the situation which prevailed in 2001. For both scenarios they simulate a much lower increase in LDC sugar exports to the EU than other studies. In the first scenario they increase by about 400 thousand tons (raw equivalents). In the second scenario which assumes a reform of the EU sugar sector LDC sugar exports under EBA increase by merely about 200 - 250 thousand tons. If the figure for the first scenario is compared to estimates by other authors (~ 2-3 million tons of total imports under EBA, see e.g. the literature cited in 2.1.2.1) they are much lower. The authors relate that to the fact, that other studies treated the raw sugar produced by LDCs and the white sugar demanded by EU consumers and industrial users of sugar are imperfect substitutes und try to justify the Armington assumption that way. The imperfect substitutability of raw and white sugar and its implication for modelers have been discussed in section 2.2. Given the fact, that Van Berkum et al. explicitly model medium run effects, which rules out the establishment of additional refining capacity either in the EU or in the LDCs, this argument can be supported.[40] The validity of their argument would, however, find its limits if one were either to investigate the long term effects, which allow for the construction of additional refineries, or increased market access for a white sugar producing country. It does furthermore not address the issue of substitutability between raw sugars of different origin. The authors conduct a sensitivity analysis with respect to their Armington parameters which are from the standard level of 2.7 increased to 5 and 10 respectively. The latter case is considered to model sugar from different origins as perfect substitutes. With that elasticity, the authors calculate increased imports of 2.7 million tons in the case of no reform and 900 thousand tons in case of implementation of the Fischler reform proposal.

The most recent CGE study surveyed here has been published by Bureau et al. (2007). They use the GOAL CGE, which has been used before by Gohin and Bureau (2006), to simulate various scenarios. Two features about this study make it different from other CGE based analyses of the sugar market. First, they run a mixed approach considering the depiction of trade for agricultural products. Some are modeled as bilaterally traded products which are heterogeneous with regard to origin. Some others, among them sugar, are modeled as homogeneous, net-traded commodities. For preferential imports of sugar in the EU this has the consequence that they cannot be modeled endogenously anymore, but they have to be

[39] This proposal differed in some regards from the reform which was finally decided in 2006. The envisaged decrease of the reference price was somewhat lower, for instance. For further details refer to the study or to European Commission (2004a).

[40] However, according to Sommer (2003) some of the LDCs are producers of white sugar.

fixed. Secondly, they evaluate the supply response of European Farmers with econometrically estimated supply functions, instead of determining supply changes endogenously. These functions account among others for cross subsidization of out-of-quota sugar. The results for supply are subsequently fed into the model to calculate overall effects of the scenarios.

Two of their scenarios are discussed here, a reference scenario and a possible outcome of WTO negotiations.[41] The reference scenario simulates a price decrease in the EU to the final reference price level of € 404 and a reduction of sugar production in the EU 15 to roughly 12 million tons. The WTO scenario simulates for sugar which the authors assume to fall in the one of four bands which is subject to highest tariff reductions. The tariff for sugar is assumed to be cut by 60%. This provides sufficient border protection to sustain a price level of € 404. The effect that such a WTO agreement has on the EU sugar market is through the abolishment of export subsidies. The authors assume this to happen via quota cuts of a corresponding amount. This will lift world market prices to € 325 in comparison to € 308 which prevailed in the reference scenario.

The study stands out by the high degree of empirical and technical detail which is used to investigate the supply behavior of EU sugar producers. In addition, the release of the Armington assumption for the world sugar market allows for a realistic prediction of competition with imports from abroad. The drawbacks of the approach are first that as a net-trade model it is unable to simulate bilateral policies and trade flows and secondly that the supply behavior of third countries is only very roughly represented.

The first partial equilibrium model surveyed in this section is one of the most well known models in of the international sugar market, the CARD International Sugar Model. It has probably the most detailed policy coverage and best empirical foundation of all global models of the world sugar market. It is used by FAPRI together with other components to establish the annual FAPRI baseline (FAPRI, 2006). The model is a dynamic, non spatial (net-trade), partial equilibrium model. Two studies which have used the model to analyze sugar policies are discussed here. The first is Elobeid and Beghin (2005). The authors simu-

[41] The original reference scenario of Bureau et al. is a continuation of current (post 2006 reform) policies without a reduction of exports to the WTO limit since, as the authors argue, sugar can be exported in the form of non-Annex I products, which is facilitated by the current situation on the world dairy market. For the review in this section, however, a scenario in which the reduction is implemented shall be considered the reference scenario.

late three liberalization scenarios in which first the trade distortions[42], then additionally the domestic distortions of production and finally also consumption subsidies are removed. The scenarios also account for effects of liberalization of policies for other crops than sugar beet and cane. The reform steps are introduced in the model in 2002/03 and the results are presented for the year 2011/12 and as averages for the transition period.[43] The FAPRI baseline from 2004 is used as a base scenario. Under full liberalization, the world market price for sugar (Caribbean fob) increases by 47%. Global production and consumption decrease by 2% on aggregate. The individual increases and decreases are, however, more pronounced. The EU-15, for instance, reduces its sugar production by around 60% and becomes a strong net importer. Japanese production decreases even stronger, by 64%. Competitive cane producers as Brazil and Australia increase their production and exports by high percentages, on the other hand. Brazil's production increases by about 18% and its exports increase by 43%. For Australia the figures are 10% and 12% respectively. Beet production generally decreases whereas cane production goes up, which meets common expectations. Sensitivity analyses carried out with respect to price elasticities of demand, supply and stock holding led in a small number of cases to extreme reactions. The directions of change predicted in the original analysis were, however, maintained in virtually all cases.

Unlike, the studies applying the Armington approach surveyed before, the analysis with the CARD model showed, under the assumption of full liberalization, expansions of trade and price effects in line with common expectations.[44] Since the model cannot explicitly account for bilateral TRQs the effects on trade flows under these TRQs in the base had to be neglected in the study.

The CARD model had been used before to simulate a sugar liberalization scenario by Beghin et al. (2003). They amend the standard version of the model by a multimarket sweetener model of the USA, which simulates the production and consumption of cane, beet, raw sugar and white sugar as well as maize and HFCS. The authors simulate the elimination of the US sugar program, i.e. import restrictions and internal price support. They perform their calculations twice, applying datasets from two different years (1996 and 1998). Using 1998 Base data, they estimate a 13.2% increase of the world market price for raw sugar. A further

[42] The domestic market price is however maintained, by assuming unlimited availability of government funds to do so. This scenario does not have any meaningful interpretation as such, but is conducted to separate specific effects of trade policies and domestic policies. Thus, only the results of the full liberalization scenario shall be discussed here.
[43] Note that the model at hand is dynamic. Here, the 2011/12 figures shall be presented.

special feature of the model is its depiction of the processing sector in the USA. This enables the authors to investigate the effects of different assumption about pass-through of sugar prices to consumers on the distribution of welfare effects of the policy changes.[45] Furthermore, the effects of substitutability between sugar and HFCS can be investigated by the model. They are, however, found to be negligible, since the possibilities of substitution are limited and industrial users of sugar and HFCS are highly specialized.

The study of Adenäuer et al. (2004) is based on a Positive Mathematical Programming (PMP) calibrated PE analysis. The authors use the CAPRI model to analyze the effects of the EBA initiative on the sugar sub-sector in the EU. CAPRI models the supply of the EU 15 on a detailed level of regional disaggregation (so-called NUTS II).

Their reference scenario is a continuation of CAP policies including the implementation of the 2003 CAP reform, but without market access for LDCs. Subsequently, the authors simulate the implementation of the EBA initiative under two different sets of assumptions. The first EBA scenario simulates the market access for LDCs with a corresponding reduction in the EU sugar quota to comply with the WTO limit of export subsidies. The second EBA scenario envisages market access for LDCs plus a larger quota cut than the other EBA scenario, sufficient to fully abolish export subsidies. The projection horizon for all scenarios is 2009. The results of the reference scenario lie by and large within expectations. Real internal and external prices for sugar decrease by 4-5%, and beet area in the EU decreases slightly due to these lower prices and due to technical progress. EU production under A and B quotas as well as imports stay rather constant whereas C production increases by 14%. As a result, exports increase by an equivalent amount. In the first EBA scenario the imports from LDCs increase from 650 thousand tons (which is the size of their protocol and SPS quotas) to 3.1 million tons. Quota production in the EU is reduced correspondingly. Due to increased production of C sugar, however, total exports of the EU increase. The price level in the EU is not affected. In the second EBA scenario, imports of quota sugar and re-exports of imported sugar are abolished. Only C-sugar is exported, about 2 million tons. Imports from LDCs increase by additional 200 thousand tons, due to a slightly higher EU price.

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[44] The authors state that the world market price increase the project is rather large, but they see it "within the ballpark of previous estimates obtained with partial equilibrium models".

[45] The overall level of welfare changes is reported to be not affected significantly by those assumptions, as well as the increase in imports and world market prices.

The strength of the CAPRI analysis is the high degree of regional disaggregation and the thus achieved detailed coverage of production constraints and interdependencies. This is, however, not the case for the regions in the model representing the LDCs. The study covers bilateral international trade relationships, though on a rough level of disaggregation, which does not allow for investigations of the export behavior of single countries. Furthermore, the study relies on the Armington assumption to depict bilateral trade. The parameters of the Constant Elasticity of Substitution (CES) demand function, have, however, apparently been chosen rather high by the authors, without which an increase in imports from LDCs of the size that is observed in the study would not have been possible.

The overview of recent economic studies of the sugar market using equilibrium models presented in this section is not comprehensive in its coverage.[46] Also a systematic comparison of the results of the studies was unfortunately not possible, given the widely differing scenario assumptions and projection horizons. It was, however, possible to show how some features of models influence the results, one the one hand by observing the degree in which the models are able to reproduce common sense expectations and on the other hand by sensitivity analyses and changes in model structure undertaken by the authors themselves. None of the surveyed studies employed the SPE approach, although it is able to combine the advantages of Armington-based and net-trade models, which are the explicit depiction of bilateral trade flows and the retention of the assumption of homogeneous goods.

Given the apparent advantages of the SPE approach and the fact that no study analyzing the world sugar market with that approach has so far been published, in this study such a model is constructed and applied to policy scenarios. In the following chapter the model itself and the simulation conducted with it are described.

[46] Overviews of some further model-based studies of the sugar market can be found in Brockmeier et al. (2005) who also carry out a model analysis themselves and FAO (2005). To include all the models listed there in the discussion of this chapter was not considered very useful. The purpose of the section was to give the reader an overview of existing approaches and techniques and their consequences on results which was achieved sufficiently. Extending the discussion would not have lead to further insights on the one hand. On the other hand some of the studies are rather old and/or publish their assumptions and results only very roughly.

4 Analysis with own Model

4.1 Model Classification and Description

4.1.1 Development of Spatial Modeling

Spatial Price Equilibrium models as opposed to non-spatial equilibrium models, which are generally referred to as net-trade models, explicitly take transport costs from any point of production to the points of consumption into account. Net trade models like the example formulated below usually consist of a system of equations that must hold simultaneously.

Net Trade Model

$$D_i = f_i(P_i) \quad (1)$$

$$S_i = g_i(P_i) \quad (2)$$

$$P_i = h_i(PW) \quad (3)$$

$$\sum_i S_i = \sum_i D_i \quad (4)$$

with

i = 1,…,n	regions
D_i	demand
S_i	supply
P_i	price
PW	world market price

The price transmission equation (3) usually reflects the trade policies of the country in question vis-à-vis the world market. Under very restrictive assumptions, the price transmission equation could account for transportation costs, too. Precisely, this would mean that the destination of exports would be exogenous to the model or that the transportation costs are unique regardless of where exports are shipped to. The reader will note that the same argument applies also for trade policies in net trade model: The model assumes the same instruments to be applied to all imports (and exports in the case of export subsidies or taxes) regardless of their source – a fact which is crucial for the discussion of modelling approaches to be applied for the analysis of the sugar market in the previous chapter.

If bilateral transportation costs (or trade policies) are to be introduced in the model it can no longer be formulated as a system of equations as the net trade model above, but must involve inequalities. This becomes apparent if one tries to add another dimension to the price transmission equation (3) which would, in the case of constant per unit transport cost, look like:

$$P_i + tc_{ij} = h_{ij}(P_j) \tag{5}$$

with

$j = 1,\dots,n$	regions
tc_{ij}	per unit transportation costs from i to j

It is obvious that equation (5) can only hold for those pairs of countries where trade actually occurs. In all other cases, the left hand side of the equation would be larger than the right hand side, which corresponds to a real world situation where it is not profitable to export from i to j.[47] To determine in which direction trade takes place is, however, a task endogenous to the model. A model taking into account bilateral transportation costs would thus look like:

Spatial Price Equilibrium Model

$$D_i = f_i(P_i) \tag{6}$$
$$S_i = g_i(P_i) \tag{7}$$
$$P_i + tc_{ij} \geq h_{ij}(P_j) \tag{8}$$
$$S_i = \sum_j X_{ij} \tag{9}$$
$$D_i = \sum_j X_{ji} \tag{10}$$

with

X_{ij}	trade flow from i to j

As indicated above, the price transmission equation (8) will hold with strict equality in those cases where trade occurs and with inequality in those cases where not.

Lacking proper mathematical algorithms to solve the above problem Enke (1951) showed in his 1951 article how a special equilibrium model with linear export supply (import demand) curves which imply domestic demand and supply curves which are also linear can be solved with an electric circuit. In such a circuit, prices and transportation costs would be analogue to voltages, export supply coefficients would be analogue to electrical resistors and trade flows would be analogue to amperages. If connected, from such a circuit ammeters and

[47] Note that the left hand side can never be larger than the right hand side in any equilibrium point, as, in a competitive market, arbitrage would occur in that case and level any differences.

voltmeters can be used to read the local prices and the directions and volumes of trade flows.[48]

One year after the Enke article Samuelson (1952) showed that the spatial equilibrium model can equivalently be cast as a maximum problem. He demonstrates how to construct a "Net-Social-Payoff"-function including the integrals under the export supply and import demand functions minus the transportation cost. With this function maximized, prices and quantities would satisfy the equilibrium conditions of the SPE described above. At the time the article was published, there was, however, no possibility to calculate the maximum of such a function other than experimentally varying the variables of the model.

Under the very restrictive assumption of non-price responsive demand and supply equations such a model could be solved with linear programming techniques, which had been developed recently before. The simplex method developed by Dantzig (1951) allows finding the optimum of a linear function subject to linear constraints as is shown below.[49]

LP

$$\begin{aligned} &\textit{Maximize} && \sum_i c_i * X_i \\ &\textit{subject to} && \sum_i a_{ij} * X_i \le b_j \\ & && X_i \ge 0 \end{aligned} \tag{11}$$

with

X_i	choice variables
a_{ij}, b_j, c_i	coefficients
$i = 1,\ldots, n$	set of variables
$j = 1, \ldots, m$	set of constraints

The simplex method has one particular advantage over the equilibrium formulation in (6) – (10), which is its ability to determine endogenously which of the inequalities will hold with strict equality and which will not. Its disadvantage is that it can only handle linear objective functions. Price responsive supply and/or demand functions would, however, even in their most simple possible form, which is a linear function, lead to a quadratic (i.e. nonlinear) net-social-payoff-function in the Samuelson sense.

An important step towards the solution of a nonlinear SPE model are the Kuhn-Tucker-Conditions (KT-Conditions, (Kuhn and Tucker, 1951)). Together with the so-called

[48] In the same paper Enke also demonstrated that for three or less countries the solution is mathematically fairly easy.

constraint qualification, they pose necessary conditions for an optimal point of a Nonlinear Programming (NLP) problem such as (12) below.[50]

NLP

$$\begin{aligned} &\text{Maximize} && f(\mathbf{X}) \\ &\text{subject to} && \mathbf{g}(\mathbf{X}) \le 0 \\ & && X_i \ge 0 \end{aligned} \tag{12}$$

with

X_i	choice variables
f	objective function
g_j	constraints
$i = 1,\ldots, n$	set of variables
$j = 1, \ldots, m$	set of constraints

To derive the Kuhn-Tucker Conditions, the Lagrangian of the NLP is formed in (13).

$$L(\mathbf{X},\boldsymbol{\lambda}) = f(\mathbf{X}) + \sum_j \lambda_j * g_j(\mathbf{X}) \tag{13}$$

The corresponding KT-Conditions of the above problem are:

KT-Conditions

$$\begin{aligned} &\frac{\partial L}{\partial X_i} \le 0 && X_i \ge 0 && \frac{\partial L}{\partial X_i} * X_i = 0 \\ &\frac{\partial L}{\partial \lambda_j} \ge 0 && \lambda_j \ge 0 && \frac{\partial L}{\partial \lambda_j} * \lambda_j = 0 \end{aligned} \tag{14}$$

with

X_i	choice variables
λ_j	slack variables
g_j	constraints
$i = 1,\ldots, n$	set of variables
$j = 1, \ldots, m$	set of constraints

The KT-Conditions show one remarkable difference compared to the first order conditions that can be derived from a Lagrangian function describing an optimisation problem

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[49] Dantzig developed the method in 1947. Isolated from western mathematicians and economists, Leonid V. Kantorovich found a similar method already in 1939 (Kantorovich, 1939; Montias, 1961).

[50] Basically, this means an NLP not fulfilling the constraint qualification may have a maximum or a minimum not fulfilling the KT Conditions. For a detailed explanation of the Constraint Qualification refer to Chiang and Wainwright (Chiang and Wainwright, 2005), Ch. 13.2.
Some publications refer to the Kuhn-Tucker-Conditions as the “Karush-Kuhn-Tucker-Conditions” (KKT-Conditions) which reflects the fact that William Karush in his Master’s thesis (Karush, 1939) “obtained identical results twelve years earlier” than they had been published by Kuhn and Tucker in 1951(Tapia and Trosset, 1994), which was, however, only revealed decades later.

with equality constraints, which are the so-called complementary slackness conditions in the third column. In an equality-constrained problem the first order derivatives of the Lagrangian must be zero. The KT-Conditions in contrast require that either the marginal equation be zero or the associated variable (or both). Exploiting complementary slackness makes it possible to determine endogenously which inequality is to hold with strict equality and which not, i.e. to find so-called corner or boundary solutions (Bishop et al., 2001).

With constraint qualification provided for, the KT-Conditions provide necessary conditions for a local optimum. For convex optimisation problems, the KT-Conditions even are necessary and sufficient conditions for a global optimum. An optimisation problem is called convex, if the feasible points of a solution form a convex set and if the objective function is convex in case of a minimum problem and concave in case of a maximum problem (Chiang and Wainwright, 2005).[51]

It is, however, in most cases not trivial to find the points satisfying these conditions. In the 1950s, when Samuelson published his article, no efficient algorithm existed to solve a nonlinear program of appropriate size. For instance, attempts to use the gradient method to find a solution of a spatial agricultural sector model of Hokkaido (with price responsive demand functions) failed (Takayama, 1992). In that decade there were thus published many studies with non-price responsive demand relying on Linear Programming (LP). The most important agricultural economist in this context was Earl O. Heady. (Heady, 1952; Heady and Candler, 1958).

Applying a modified Simplex-algorithm developed by Wolfe (1959) which was able to deal with Quadratic Programming (QP) problems[52], Takayama finally succeeded to solve his Hokkaido model and together with G. J. Judge to apply QP to the Samuelson framework (Takayama and Judge, 1964a; Takayama and Judge, 1964b). Ever since, their approach has been applied numerous times to real world problems.

To use the QP approach it is, however, necessary that the equations of the model satisfy the so-called "integrability condition". Otherwise, the net-social-payoff function Samuelson had in mind cannot be derived unambiguously. This is e.g. the case when the matrix of coefficients of the demand and supply functions in the multi product case is not

[51] Arrow and Enthoven (1961) showed that, under certain conditions, the sufficiency of the KT-Conditions can also be extended to the case of quasiconvex programming.

symmetric (Takayama and Judge, 1971).[53] In that case, no unique net-social-payoff function can be derived and hence maximized. Other cases in which the model is not integrable are the presence of discriminatory ad valorem tariffs or different interest rates over regions (Arndt et al., 2001; Langyintuo et al., 2005). In those cases, a SPE can be formulated as a Linear Complementarity Problem (LCP). The general form of a LCP is shown in (15) (Cottle et al., 1992):

LCP

$$\begin{aligned} \mathbf{z} &\geq 0 \\ \mathbf{q} + \mathbf{M}\mathbf{z} &\geq 0 \\ \mathbf{z}^T(\mathbf{q} + \mathbf{M}\mathbf{z}) &= 0 \end{aligned} \tag{15}$$

with

$\mathbf{z}, \mathbf{q} \in R^n$

$\mathbf{M} \in R^{n \times n}$

For a QP it can be shown, that (15) is equivalent to its corresponding KT-Conditions.[54] QPs form a subset of LCPs for which an efficient solving algorithm called the *principal pivoting method* had been developed by Cottle and Dantzig (1968) building on the work of Lemke and Howson (1964).

With growing computational capacities and the development of appropriate solution algorithms it became possible to solve mixed complementarity problems (MCP). These are a generalization of LCPs in that they are able to handle non-linear functions instead of merely linear ones on the one hand and a mixture of equality and inequality constraints instead of merely inequality constraints on the other hand (Billups et al., 1997). The general form of a MCP is shown below in (16) (Rutherford, 1995):

MCP

Given: $F(\mathbf{z})$, $\mathbf{l}$, $\mathbf{u}$ (16)

Find: $\mathbf{z}$, $\mathbf{w}$, $\mathbf{v}$

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[52] Quadratic programming problems are a subset of nonlinear programming problems. The former are restricted to a quadratic objective function and linear constrains, whereas the latter allow for nonlinearities of higher order than quadratic in objective functions and constraints (Bishop et al., 2001).

[53] Modellers using supply and demand functions which are merely locally symmetric (as e.g. isoelastic functions) encounter a similar problem when calculating welfare effects of policy changes: The results are not unambiguous as they depend on the path of integration (See e.g. Grethe (2004) Ch. 5.8).

[54] The vector **z** in this case would correspond to choice and slack variables in (14) and matrix **M** and vector **q** correspond to the coefficients of the (linear) first order derivatives of the Lagrangian.

subject to:

$$F(\mathbf{z}) - \mathbf{w} + \mathbf{v} = 0$$
$$\mathbf{l} \le \mathbf{z} \le \mathbf{u}\,,\ \mathbf{w} \ge 0\,,\ \mathbf{v} \ge 0$$
$$\mathbf{w}^T(\mathbf{z} - \mathbf{l}) = 0\,,\ \mathbf{v}^T(\mathbf{u} - \mathbf{z}) = 0$$

with
$F : R^N \to R^N$
$\mathbf{l}, \mathbf{u} \in R^N$
$\mathbf{z}, \mathbf{w}, \mathbf{v} \in R^N$

Besides linear and nonlinear programs and complementary problems, MCPs are a generalization of many problems in mathematics and optimisation, for instance systems of linear and nonlinear equations. For the practical purpose of SPE modelling, the MCP formulation has the advantage that it allows demand and supply functions to be nonlinear.

4.1.2 Model Description

After having explained the mathematical fundamentals of the modeling approach to be applied in this study in section 4.1.1, in this section the model itself is described in its basic structure and with respect to base data parameter choice and calibration.

4.1.2.1 Model Structure

The model used for this study is a SPE model. It covers 104 regions of production and 90 regions of consumption. The regional coverage is shown in tables 4-1 and 4-2. The model is a one product model with sugar as the sole product. Sugar is modeled in white sugar equivalents (WSE, = refined equivalents). All demand functions and the supply functions for sugar cane producing countries are isoelastic. The supply functions for beet sugar production in the EU-27 member states, Turkey, Switzerland, Japan and the USA employ a different functional form.[55] The supply functions do not disaggregate yield and area effects. Supply quantities in the model represent only processed sugar, raw and white. The production of sugar crops for other uses, chiefly ethanol, is ignored.[56]. All demand and supply curves are functions of the own price solely and of effective producer and consumer subsidies. Income elasticities are not modeled explicitly. They are, however, implicitly accounted for in the annual shifters of demand growth over time. Since assumptions about GDP growth do not differ among the various scenarios, the effect is the same. Stocks and stock changes are not

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[55] The USA is the only country in the model with two supply functions, one for beet sugar and one for cane sugar.

modeled explicitly. All prices are expressed in real 2005 Euro. Effects of different inflation rates and changes in exchange rates are, thus, not accounted for.

Table 4-1: Regional Coverage of the Model – Production Regions

Region	Code	Region	Code	Region	Code	Region	Code
Austria	AT	Benin	BEN	Barbados	BAR	Bangladesh	BAN
Belgium &	BE	Burkina	BUR	Belize	BEL	China	CHN
Luxemburg		Faso		Canada	CAN	India	IND
Czech Rep.	CZ	Congo, D.R.	CDR	Costa Rica	COR	Indonesia	INS
Denmark	DK	Congo, R.	CON	Cuba	CUB	Iran	IRN
Spain	ES	Côte	COT	Dominican	DOM	Japan	JAP
Finland	FI	d'Ivoire		Rep.		Malaysia	MLY
France	FR	Egypt	EGY	El Salvador	ELS	Nepal	NEP
Germany	GE	Ethiopia	ETH	Guatemala	GUA	Pakistan	PAK
Greece	GR	Gabon	GAB	Honduras	HON	Papua New	PNG
Hungary	HU	Guinea	GUI	Jamaica	JAM	Guinea	
Ireland	IE	Kenya	KEN	Mexico	MEX	Philippines	PHI
Italy	IT	Madagascar	MAD	Nicaragua	NIC	Thailand	THA
Lithuania	LT	Malawi	MAL	Panama	PAN	Rest of Near	RNE
Latria	LV	Mauritius	MAU	St. Kitts &	STK	East	
Netherlands	NL	Mali	MLI	Nevis		Rest of	RSA
Poland	PL	Morocco	MOR	USA-Beet	UB	South and	
Portugal	PT	Mozambique	MOZ	USA-Cane	UC	Central Asia	
Slovenia	SI	Nigeria	NIG	Trinidad &	TRI	Rest of East	REA
Slovak Rep.	SK	South Africa	SAF	Tobago		Asia	
Sweden	SW	Senegal	SEN	Rest of	RCA	Australia	AUS
United	UK	Sierra Leone	SRL	Caribbean		Fiji	FIJ
Kingdom		Sudan	SUD	Argentina	ARG	Rest of	RSO
Bulgaria	BUL	Swaziland	SWA	Bolivia	BOL	South-East	
Romania	ROM	Tanzania	TAN	Brazil	BRA	Asia and	
Turkey	TUR	Uganda	UGA	Chile	CHL	Oceania	
Albania	ALB	Zambia	ZAM	Columbia	COL		
Russia	RUS	Zimbabwe	ZIM	Ecuador	ECU		
Serbia	SER	Rest of Sub	RAF	Guyana	GUY		
Switzerland	SWI	Sahara		Paraguay	PAR		
Rest of	REU	Africa		Peru	PER		
Europe				Suriname	SUR		
				Uruguay	URU		
				Venezuela	VEN		

Source: Own compilation.

[56] The effect of ethanol-based demand for sugar crops is implicitly accounted for by the calibration of technical progress shifters to meet FAPRI (2006) world market price projections.

Table 4-2: Regional Coverage of the Model – Consumption Regions

Region	Code	Region	Code	Region	Code	Region	Code
EU-25	EUR	Algeria	ALG	Barbados	BAR	Bangladesh	BAN
Bulgaria	BUL	Benin	BEN	Belize	BEL	China	CHN
Romania	ROM	Burkina Faso	BUR	Canada	CAN	India	IND
Turkey	TUR	Congo, D.R.	CDR	Costa Rica	COR	Indonesia	INS
Albania	ALB	Congo, R.	CON	Cuba	CUB	Iran	IRN
Bosnia and Herzegovina	BOS	Côte d'Ivoire	COT	Dominican Rep.	DOM	Japan	JAP
Norway	NOR	Egypt	EGY	El Salvador	ELS	Malaysia	MLY
Russia	RUS	Ethiopia	ETH	Guatemala	GUA	Nepal	NEP
Serbia	SER	Gabon	GAB	Haiti	HAI	Pakistan	PAK
Switzerland	SWI	Guinea	GUI	Honduras	HON	Papua New Guinea	PNG
Rest of Europe	REU	Kenya	KEN	Jamaica	JAM	Philippines	PHI
		Madagascar	MAD	Mexico	MEX	South Korea	SOK
		Malawi	MAL	Nicaragua	NIC	Thailand	THA
		Mauritius	MAU	Panama	PAN	Rest of Near East	RNE
		Mali	MLI	St. Kitts & Nevis	STK	Rest of South and Central Asia	RSA
		Morocco	MOR	USA	USA	Rest of East Asia	REA
		Mozambique	MOZ	Trinidad & Tobago	TRI	Australia	AUS
		Nigeria	NIG	Rest of Caribbean	RCA	Fiji	FIJ
		South Africa	SAF	Argentina	ARG	Rest of South-East Asia and Oceania	RSO
		Senegal	SEN	Bolivia	BOL		
		Sierra Leone	SRL	Brazil	BRA		
		Sudan	SUD	Chile	CHL		
		Swaziland	SWA	Columbia	COL		
		Tanzania	TAN	Ecuador	ECU		
		Togo	TOG	Guyana	GUY		
		Uganda	UGA	Paraguay	PAR		
		Zambia	ZAM	Peru	PER		
		Zimbabwe	ZIM	Suriname	SUR		
		Rest of SACU	SAC	Uruguay	URU		
		Rest of Sub Sahara Africa	RAF	Venezuela	VEN		

Source: Own compilation.

In this paragraph the approach of choosing non-isoelastic supply functions for some beet producing countries is briefly explained. It has first been applied for a better representation of the sugar market in the ESIM model by Nolte and Grethe (2007).[57] The most important reason for the decision not to apply isoelastic supply functions in some countries is that those functions do not allow production to cease at a positive price. Additionally, unless one chooses extremely high elasticity values production cannot even be simulated to decrease

[57] For a more detailed explanation the reader may refer to that publication.

considerably, say by 80%, in the case of price changes in the order of size which is envisaged by the 2006 CMO reform of sugar. To model the effects of large price changes on highly protected beet sugar markets another functional form is chosen. While an isoelastic function is shaped as follows,

$$S_i = \beta * P_i^{\gamma} \tag{1}$$

with

i	region
Si	supply
pi	price
β	intercept parameter
γ	elasticity

the functional form used here contains an (negative) additive intercept, α, on the quantity axis. This allows the function to fall to zero at a positive producer incentive price. To prohibit the produced quantity to become negative the supply function is put as an argument in a MAX function.[58]

$$S_i = MAX\left\{0, \left(\alpha + \beta * P_i^{\gamma}\right)\right\} \tag{2}$$

The shape of two examples of both functional forms is shown in figure 4.1. The quantities as well as the producer incentive prices are equal for both forms in the point of calibration, but decreasing the price leads to different supply responses. At about 60% of the initial price level the production is simulated to cease with the non-isoelastic supply curve in this example.

[58] Note that in equation (2) γ is not an elasticity anymore.

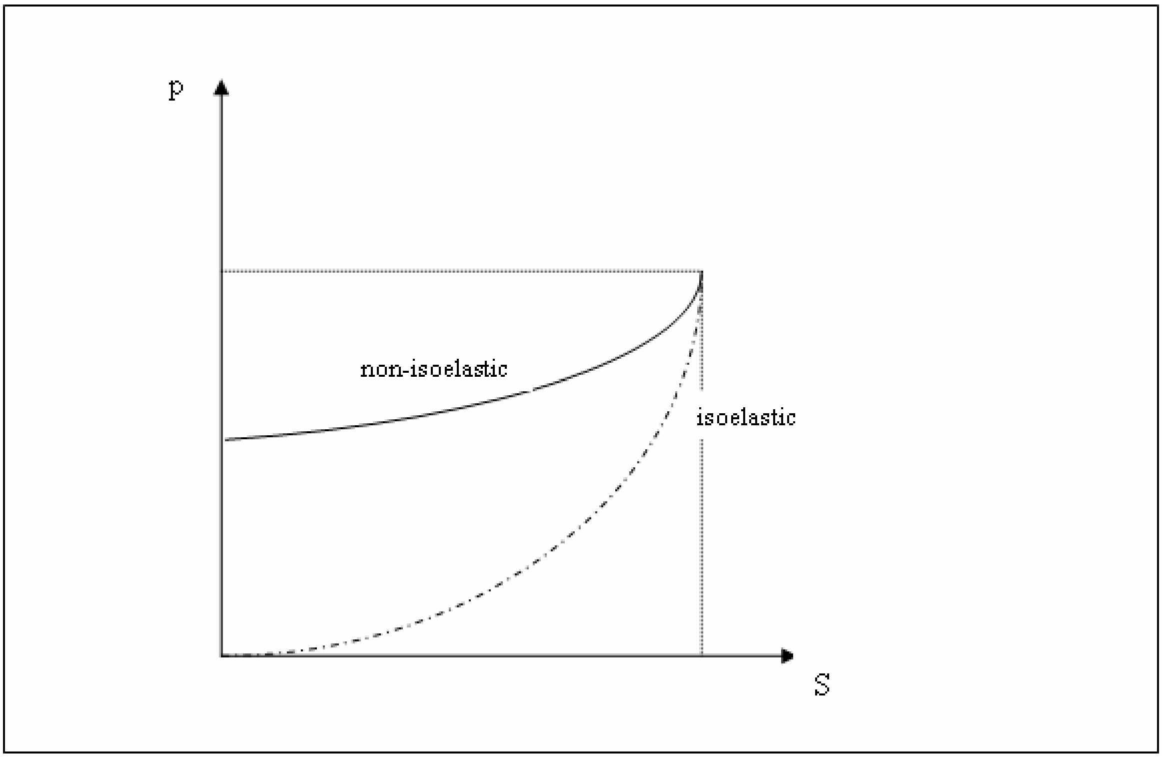

Figure 4-1: Functional form of beet supply in the model compared to an isoelastic function

Source: Own Graph.

The whole set of equations of the model looks as follows:

$$D_i = \alpha * (PD_i + consumersubsidy_i)^{\varepsilon_i} \tag{3}$$

$$S_k = \gamma_k * (PS_k + producerersubsidy_k)^{\delta_k} \tag{4a}$$

$$S_l = MAX[0, \{\beta_l + \gamma_l * (PS_l + producerersubsidy_l)^{\delta_l}\}] \tag{4b}$$

$$D_i \le \sum_{sch} \sum_j X_{sch,j,i} \tag{5}$$

$$S_j \ge \sum_{sch} \sum_i X_{sch,j,i} \tag{6}$$

$$S_j \le quota_j \tag{7}$$

$$X_{sch,j,i} \le trq_{sch,j,i} \tag{8}$$

$$\begin{aligned}&(PS_j + PSH_j + PQ_{sch,j,i} + exw\_fas_j \\ &+ loading_j + freight_{j,i} + tc_{sch} - ex\_sub_{j,i}) \\ &*(1 + tar\_av_{sch,j,i}) + tar\_sp_{sch,j,i} \\ &+ unloading_i + inld\_transport_i \ge PD_i\end{aligned} \tag{9}$$

with

i	consuming regions
j	producing regions

$k \subset j$	producing regions with isoelastic supply
$l \subset j$	producing regions with non-isoelastic supply
sch	trade scheme
D_i	demand
PD_i	consumer price
$consumersubsidy_i$	consumer subsidy
S_j	supply
PS_j	producer price
$producersubsidy_j$	producer subsidy
$\alpha, \beta, \gamma, \delta$	parameters of demand and supply functions [a]
$X_{sch,j,i}$	trade flows
PSH_j	rental price for production quota
$PQ_{sch,j,i}$	rental price for TRQ
$quota_j$	production quota
$trq_{sch,j,i}$	TRQ
exw_fas_j	transportation cost from factory to port
$loading_j$	vessel loading cost
$freight_{j,i}$	ocean freight
tc_{sch}	transaction cost for preferential schemes
$ex\_sub_{j,i}$	export subsidy
$tar\_av_{sch,j,i}$	ad valorem tariff
$tar\_sp_{sch,j,i}$	specific tariff
$unloading_i$	vessel unloading cost
$inld\_transport_i$	transportation cost from port to place of consumption

[a] ε_i and δ_k are demand and supply elasticities in equations 3 and 4a.

The model is programmed in GAMS (General Algebraic Modeling System) as a MCP and solved with the PATH solver (Dirkse and Ferris, 1995). As described in chapter 4.1.1, the MCP formulation stems from the KT formulation of an underlying optimization problem. The KT conditions require complementary slackness of constraints and slack variables. In the same manner the MCP formulation of a SPE requires each inequality constraint to be mapped with one variable of the same dimension, which is to vanish in case the inequality does not hold with strict equality. For the model applied in this study the mapping looks as follows:

$$D_i \leq \sum_{sch} \sum_{j} X_{sch,j,i} \qquad \perp PD_i \geq 0$$

$$S_j \geq \sum_{sch} \sum_{i} X_{sch,i,j} \qquad \perp PS_j \geq 0$$

$$S_j \leq quota_j \qquad \perp PSH_j \geq 0$$

$$X_{sch,j,i} \leq trq_{sch,j,i} \qquad \perp PQ_{sch,j,i} \geq 0$$

$$\begin{aligned}&(PS_j + PSH_j + PQ_{sch,j,i} + exw\_fas_j \\ &+ loading_j + freight_{j,i} + tc_{sch} - ex\_sub_{j,i}) \\ &*(1 + tar\_av_{sch,j,i}) + tar\_sp_{sch,j,i} \\ &+ unloading_i + inld\_transport_i \geq PD_i\end{aligned} \qquad \perp X_{sch,j,i} \geq 0$$

A lot of features which have been identified as useful for modeling the sugar market in section 2.2 are not implemented in the model used for this study. The most relevant of these are the distinction between raw and white sugar, the accommodation of substitutes in production and consumption of sugar crops and sugar, the separation of modeling of sugar crop production and the first stage of processing and the formulation as a dynamic model to account for time lags in production adjustment. The neglecting of these features is in general due to the limited scope of the study and the limited resources in terms of manpower and data availability. In the last chapter, however, the potential usefulness of a possible future implementation of each of those features will be discussed again in the light of the results obtained in this study.

4.1.2.2 Base Data, Parameters and Calibration

4.1.2.2.1 <u>Quantities</u>

All quantities in the model refer to processed, raw or white, sugar. The production of sugar crops and the first stage of process

Supply and demand data are for most countries extracted form F.O. Licht (2007). Data for countries which were not available from that source are extracted from ISO (2007). All Data are three years averages from 2003/04, 2004/05 and 2005/06. Supply Data for the EU-27 countries are adopted from the ESIM Model which has the same Base period. Since the model does not account for stocks and stock changes, supply and demand needs to be balanced to obtain a reproducible set of base data. Supply of sugar is fluctuating much stronger than demand, as it is affected more by price and climate fluctuations. It makes, hence, more sense to alter the supply than the demand to balance the database. Thus, production in most countries is scaled downwards (by slightly less than 4%) to meet the demand in the base period.

Some countries are treated differently during the compilation of the database, which is described in this paragraph. Firstly, India and Thailand, two major sugar producers, suffered from years of severe drought in the base period. To put that three years average for their production data in the database would in future years have strongly underestimated their supply. Data for these two countries is therefore extracted from FAPRI (2006) for the first projection year (2006/07).[59] The next country for which a different approach for the collection of base data is pursued is the United States. As described above in the policy section, production is limited by marketing allotments and imports are limited by TRQs. Both are decided upon on an annual base depending on the situation on the US market, the world market and the export potential of the TRQ holders. Since for a non-expert in US sugar policies those decisions are hard to predict, FAPRI projections are used to determine marketing allotments (= supply), demand, and the overall level of TRQs (= imports).[60] Finally, the data for Mexico is treated differently. It is, as for most other countries, taken from F.O. Licht (2007). It is, however, not scaled downwards in the process of balancing demand and supply for the base. The reason for that is that it would change the net-trade situation of Mexico. Mexico is currently an exporter of small quantities. Those are shipped under NAFTA market access to the US and are reason for hot debates there. To be able to depict those traded quantities, Mexican supply is omitted from scaling.

4.1.2.2.2 Prices

Most prices which are in the database of the model are not extracted from statistical sources, but determined endogenously in a calibration run of the model. That procedure will be described in detail in section 4.1.2.2.5 further down. The prices which entered the model exogenously are the world market price for white sugar (London, fob, average of 2003/04 and 2004/05) which is extracted from European Commission (2007), the producer incentive and consumer prices for the EU-27 countries which are extracted from the ESIM Model (BANSE ET AL., 2007), the producer incentive prices for Turkey (USDA, 2007, *GAIN Report TU7030*), prices in Japan (USDA, 2006, *GAIN Report JA6008*) and South Africa (USDA, 2005, *GAIN Report SF5009*) and consumer and producer incentive prices in the US (Elobeid and Beghin, 2005; Haley and Suarez, 2004).[61]

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[59] Taking into account technical progress, this procedure would overestimate production. Therefore, those figures are reduced by the rate of one years technical progress.

[60] Sugar Exports under the re-export program are ignored in the model.

[61] For details please refer to the policy description section.

4.1.2.2.3 Transportation Costs

One of the most important features of a SPE model is the consideration of bilateral transportation costs. These consist of a number of cost-sub-categories mentioned in section 2.1.1. Regarding the poor availability of data on costs of inland transport, i.e. from the place of production to the place of consumption or the port and from the port to the place of consumption a simple approach is chosen. Costs for inland transports are always set at € 10 per ton for industrialized and at € 15 per ton for developing countries. The same holds for loading and unloading costs in ports. These are universally set at € 7 per ton for industrialized countries and at € 10.50 for developing countries. Costs for landlocked countries to transport sugar to ports of neighbouring countries are according to Garside et al. (2004), who review the case of Malawi, set at € 70 per ton. This approach, to say the least, has some scope for improvement by better empirical foundation. At least, the broad order of size of those cost components is verified empirically, though.

The availability of data is much better for ocean freight rates, at least were routes are concerned that are frequently used in the international trade of raw sugar. For the routes for which ocean freight rates are published by the ISO the averages for 2004/05 are applied for the base period of the model. For projections, the function estimated in chapter 2.1.1.4 containing the BDI as only explaining variable is used. For other routes the regionally estimated regression functions which are functions of the distance, the BDI, and the canal passages are applied. The arithmetic mean of costs calculated with the regional coefficients of the importing and those calculated with coefficients of the exporting country is then calculated. To partly mitigate the problem of underestimation of the distance effect discussed in chapter 2.1.1.4, costs for the same routes are again estimated with the coefficients estimated from the whole dataset and the arithmetic mean of both is taken as the final costs.[62] To illustrate that somewhat complicated procedure, figure 4-2 describes as an example how the final ocean freight rate on the route between Costa Rica and Algeria is estimated.

[62] For the sake of transparency, the such estimated ocean freight rates are rounded to integers, finally

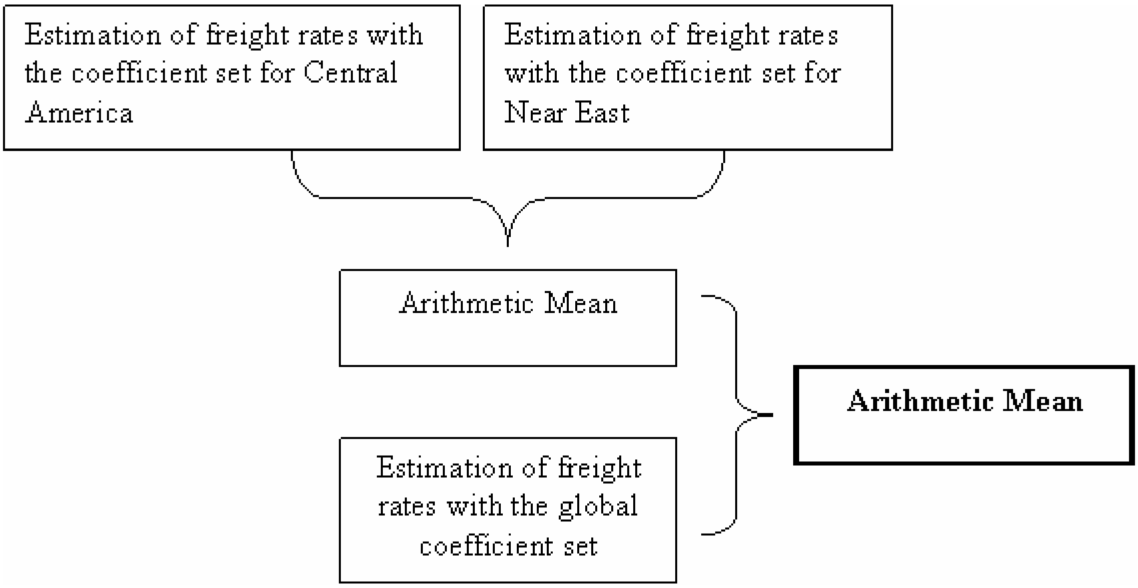

Figure 4-2: Example of Estimation of Ocean Freight Rates for Sugar between Costa Rica and Algeria

Source: Own compilation.

4.1.2.2.4 Elasticities, Technical Progress and Demand Growth

Parameters used in the model are elasticities and parameters for non-isoelastic functions, rates of technical progress and demand growth (combined effect of population growth and income growth) and inflation rates of the Euro. Elasticities of demand and supply with respect to the own price are taken from Stout and Abler (2003) and from FAPRI (2007). Parameters for non-isoelastic supply functions for the EU-27 are taken from Nolte and Grethe (2007). Non-isoelastic supply functions for other countries are obtained by scaling the supply function of one EU-27 country which from its geographical and economical situation is regarded similar to the country in question to meet that country's price-supply-combination. These are Austria for the Swiss and Japanese supply function and France for the US beet sugar supply function.[63] Technical progress and demand growth shifters for demand and supply functions of EU-27 countries and the other non-isoelastic supply functions are extracted from Banse et al. (2007) and adjusted in some cases. Rates of technical progress and demand growth for all other functions are estimated by log-linear regression from data of the FARPI (2006) projection horizon. The rates of technical progress for most countries are adjusted later to meet the FAPRI baseline projections for the world market price movement. For the demand shifters of the US a different approach is applied. They are set such that in every year of the projection horizon the FAPRI projections are exactly met at a nominally

[63] Note that this does not apply to the level of prices or shadow prices respectively, which are unique for each of these countries.

constant consumer price for sugar.[64] The inflation rate of the Euro is extracted as a weighted average of European Monetary Union members from Banse et al. (2007).

4.1.2.2.5 Calibration of the Model

After entering all base data and policies (see chapter 4.1.2.3) in the model, a calibration run is started. Equations (3) and (4) (see chapter 4.1.2.1) are disabled and all quantities are fixed. The prices exogenously determined (see chapter 4.1.2.2.2) are fixed as well. Now the model is run. This altered model is basically of the same structure as the Hitchcock-Koopmans transportation cost minimization problem and could be solved by a LP solver. The user in this case is, however, not interested in the primal solution which is the minimum transportation cost (in our case transportation costs and tariffs) combination of trade flows, but in the dual solution which is the prices of demand and supply. After the run, the prices for supply and demand obtained are fed into the model for calibration of supply and demand functions.

Also the primal solution is of some interest. As pointed out frequently, the SPE approach in its development is an offspring of normative economic models such as LP or QP and it still has retained one important property of those approaches: It is not possible, to reproduce any arbitrary set of base data, unless it is an optimal solution to the model under given constraints. This is so for two reasons which usually apply at the same time. The first is that the model simulates optimizing behavior under total information and full rationality of all agents which is, of course, merely an approximation of reality. The second is that the modeler, for many reasons, will never be able to fully capture all constraints faced by the agents whose behavior is simulated. Many other modeling approaches can escape this dilemma by calibrating behavioral functions. In an SPE framework this is not entirely possible.[65] The base solution of the model generated by the calibration run will, therefore, most probably differ from what can be observed in reality. The extent to which it differs from what can be observed, can, however, be seen as an indicator of how well the model captured the relationships and constraints prevailing in the simulated setting. It can also give some hints on how to improve the model by altering the relationships and constraints or, if the modeler is unable to explain why one certain result is so far away from reality, can indicate points where empirics are especially in need to be improved. Two such examples are discussed here to demonstrate that. The first is the composition of imports to Norway. In reality

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[64] For a detailed explanation of that procedure refer to section 4.1.2.3.2 where the implementation of US policies in the model is described.

[65] We shall come back to this issue in the final chapter.

those consist more or less completely of shipments from the EU (ISO, 2007). The calibration run of the model, however, shows imports of Norway coming entirely from southern African LDCs which can export duty free to Norway (UNCTAD, 2007). The explanation which seems to be obvious is that Norway does not have a refining industry and, thus, has to import refined sugar. This is an example for a differing result which shows a misspecification of real world relationships and constraints in the model. The lesson is that the model could be improved by modeling raw and white sugar production and a refining activity instead of converting all sugar into WSE as is done here.[66] The second example is the import composition of Canada. In reality Canada is supplied mainly by Central and South American countries (ISO, 2007), which is reproduced satisfactorily by the calibration run. What is not reproduced, though, is a considerable share of sugar imported from Australia. Unlike the Norwegian case, this case does not give an apparent hint at what might be specified wrongly in the model. This could be an overestimation of transportation cost between Australia and Canada or a special quality of raw sugar (Largely all Canadian imports of sugar are raw) which fetches a better price by Canadian refiners. Only further empirical investigation can shed light on that question.

Another issue about this calibration is the reproduction of the world market price. As indicated above, the growth parameters are adjusted so as to meet the world market price projections of the FAPRI baseline. The world market price used as a benchmark for the SPE model in this study is, however, the London fob price for white sugar extracted from European Commission (2007), whereas the price published by FAPRI (2007) is the Caribbean fob price for raw sugar. These prices are, of course, not identical, since the two markets are spatially separated. However, even the Caribbean fob price in the base period of the SPE model used here is not identical to the one published by FAPRI for the same period, either.[67] This is in part attributable to the application of WSE in this study. However, even if the price by FAPRI is multiplied by an extraction factor and refining costs are added, there is still some deviation from the price used in the model. The way of calculating one price with information about the other is rather complicated, but, of course, possible, since an economic equilibrium exists between both prices. A numerical example which fits the prices of the base period of the model (2004-2005) is presented below. The market in which Caribbean and European exporters compete with each other is the Middle East, where both regions export

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[66] The same is true, of course, for a conversion of all sugar into raw equivalents which is done in other models.
[67] The prices for the base period of the model (2004-2005) published by FAPRI (2006) are not projections but historical prices extracted from data of the Intercontinental Exchange (2007), formerly New York Board of Trade (NYBOT).

sizeable quantities to. Since sugar is consumed mostly as white sugar, it is the white sugar price in the Middle East which is the connector of both regions' world market prices. A Caribbean raw fob price of US$ 202 per ton corresponds after adding transportation and refining costs to a white sugar price in the Middle East of US$ 336 or € 274 per ton:

Price/Costs	**Value**	**Source**
Caribbean raw fob price:	US$ 202	FAPRI (2006)
+ Transportation costs to Middle East	US$ 44	ISO (various years)
= Middle East cif price	US$ 246	
+ Discharging costs	~US$ 12	Extracted from the model and multiplied by exchange rate
= Middle East cif landed price	US$ 258	
+ Refining losses and cost	X /0.92	Sommer (2003)
	+ US$ 55	
= Middle East cif landed price for white sugar	US$ 336	
Exchange Rate: 1.22642 US$/€	€ 274	OANDA.com (2007)

A similar calculation for the London white sugar fob price results in a white sugar price in the Middle East of € 270 per ton, which is quite close to the price calculated with the Caribbean price as a base:

Price/Costs	**Value**	**Source**
London white fob price:	€ 191	European Commission (2007)
+ Transportation costs to Middle East (white)	€ 55	ISO (various years), OANDA.com (2007)
= Middle East cif price	€ 246	
+ Discharging costs (white)	~€ 24	House of Lords (2005)[68]
= Middle East cif landed price	€ 270	

Since the model depicts all sugar in WSE, this result can not be reproduced. The calibration results in a Caribbean fob (stowed) price for white sugar in the base period of € 185, which does, as indicated above, not correspond to the price one would end up if converting the raw sugar price used by FAPRI into WSE by dividing with the extraction factor and adding refining costs:

[68] The ratio between unloading costs for raw and white sugar which are stated there is applied to calculate white sugar unloading costs in the Middle East from raw sugar unloading costs

Price/Costs	Value	Source
Caribbean raw fob price:	US$ 202	FAPRI (2006)
+ Refining losses and cost	X /0.92	SOMMER (2003)
	+ US$ 55	
= Caribbean white fob price	US$ 275	
Exchange Rate: 1.22642 US$/€	€ 224	OANDA.com (2007)

The adjustments of the function shifters to meet the FAPRI projections is therefore carried out such, that the Caribbean white fob price in the model shows the same absolute movements as the FAPRI projections for the Caribbean raw fob price. The Caribbean white fob price in the model is also used as a benchmark for the world market price in the scenario simulations carried out in section 4.2. Why is this done? The model is programmed with a European view: European sugar policies are modeled more detailed than those of most other countries, European supply curves are implemented with a special functional form to better account for the producers' behavior and most important, the European (London) fob price is used as a benchmark for the calibration of the model. So why not keep on using the London fob price as a benchmark for the world market price? The answer is simple: After the implementation of most scenarios, there will be no London fob price anymore, as the EU will not export sugar anymore.

4.1.2.2.6 Validation of the Model

As has been pointed out in section 4.1.2.2.5, the primal solution of the calibration run of the model, the resulting matrix of bilateral trade flows, will likely deviate from what is observed in reality. To assess, how well the model is able to capture the determinants of real world trade flows, it is, therefore, interesting to compare this primal solution to these trade flows.

For this purpose, bilateral trade flows of white sugar, raw cane sugar and raw beet sugar[69] are extracted from the SITA-Database (Statistics for International Trade Analysis) (ITC, 2007b) for the years 2003 - 2005. The database captures every trade flow from country A to country B twice: once as imports of B from A, and once as exports of A to B. Theoretically, these should resemble each other. To assess the quality of the data on the one hand, and to obtain a benchmark of how consistent data for bilateral trade flows from different

[69] The reader will notice a contradiction to chapter 2 where sources are cited that say sugar beet are not processed to raw sugar, but always directly to white sugar. The average amount of raw beet sugar trade in the SITA statistics is, however, less than one percent of trade of all sugar of the three mentioned categories.

sources[70] are on the other hand, as a first step, a consistency check of the data is performed. As a second step, the data for bilateral trade flows from the base period of the model is compared by the same method to the average of the aggregate (in WSE) sugar trade flows from the SITA-Database.

It is not a trivial question which method to use for such a consistency check of trade data. The most apparent one would be to use a weighted average of deviations between trade flows extracted from different sources as is shown in equation (10):

$$\frac{\sum_{y,p}\left|{IM_{y,p,i,j}}\big/{EX_{y,p,i,j}}-1\right| * \frac{IM_{y,p,i,j}+EX_{y,p,i,j}}{2}}{\sum_{y,p,i,j}\frac{IM_{y,p,i,j}+EX_{y,p,i,j}}{2}} \tag{1}$$

with

p	product (raw cane, raw beet, white sugar)
y	year
i	exporting region
j	importing region

This would, however, lead to the undesired consequence, that if imports of j from i are stated 50% lower than exports from i to j, this would lead to a different result (50% deviation) than if exports from i to j were stated 50% lower than imports of j from i (100% deviation). To solve this problem, one could use logarithms instead since

$\log(\frac{x}{y}) = -\log(\frac{y}{x})$ and thus $\left|\log(\frac{x}{y})\right| = \left|\log(\frac{y}{x})\right|$.

Replacing $\left|{IM_{y,p,i,j}}\big/{EX_{y,p,i,j}}-1\right|$ in (10) by $\left|e^{-\left|\log\left(\frac{IM_{y,p,i,j}}{EX_{y,p,i,j}}\right)\right|}-1\right|$

will evaluate deviations such as the example discussed above equally. It behaves as if it were always using the bigger of both numbers as a denominator in (1), i.e. it results in both of the

[70] Strictly speaking the data are all extracted, of course, from only one source (ITC, 2007b).

above cases in a deviation of 50%. Applying this method to import and export statistics of sugar in the SITA database from 2003 – 2005 this results in an average weighed deviation of 53.8%.

Another method for comparing two such datasets is the calculation of Pearson's product-moment correlation coefficient r.[71] The result for r of the analyzed SITA sugar trade data is 0.585 and significant at the 0.01 level.

If the trade data from different categories of sugar are aggregated to WSE and/or averages over the three years are calculated, both indicators improve their values (i.e. average weighed deviation decreases, r increases), as is shown in table 4.3.

Table 4-3: Consistency of Import and Export Data from the SITA Database

	Average weighted deviation	r
Total Sample (3 product categories, 3 years; 3933 trade flows)	53.8%	0.585***
3 years average, 3 product categories (1896 trade flows)	48.5%	0.702***
WSE, 3 years (2611 trade flows)	48.3%	0.660***
WSE, 3 years average (1190 trade flows)	43.9%	0.756***

Source: Own calculations; *** significant at the 0.01 level.

In the next step, the same methods are applied to the average (of imports and exports) aggregated trade data from the SITA database and the trade flows that emerge after calibration of the model. However, the data for production and consumption and the data for bilateral trade are taken from different sources, which are usually not fully consistent. I.e. the balance of imports and exports from the trade data, does not match the balance of production, consumption and stock changes, which is, of course, essential for base data of an equilibrium model. Additionally, as has been mentioned above, the model does not account for stock changes. Thus, in the model, the balance of production and consumption in the region always equals its net-exports. In reality, however, exports and imports and thus their balance will due to stock changes most probably be different from the balance of internal production

[71] Mathematically this is identical to the square root of the r^2 of a linear regression of imports as a function of exports or vice versa.

and consumption. To correct for this inconsistency, imports are scaled on a country base to meet the total level of imports of that country and the validation is carried out a second time. Likewise, exports are scaled on a country base and the validation is performed again. Table 4.4 thus has three rows, the first of which shows the results of the validation performed with the original data, and the second and third rows show the results for the scaled data.

Table 4-4: Consistency of SITA Data and the Base Trade Flows of the Model

	Average weighted deviation	r
Original data	71.1%	0.681***
Scaled to meet total imports	63.9%	0.716***
Scaled to meet total exports	58.8%	0.669***

Source: Own calculations; *** significant at the 0.01 level.

The average deviation between the SITA data and the model base trade flows is 71.1%. This improves significantly if the data is scaled to meet country imports or exports. The correlation coefficient, which is 0.681 for the original data set does only improve for one of the scaled data sets. For the export-scaled data set, it deteriorates slightly. An attempt to rerun the validations with a data set that does include imports under TRQs, which are basically predetermined, does not change the results significantly. This is actually not surprising, since TRQs account for only 4 million tons out of roughly 34 million tons of international sugar trade.

Table 4-5: Consistency of regionally aggregated trade flows

	Average weighted deviation	r
SITA imports/ SITA exports	32.5%	0.853***
Model data/ SITA	45.6%	0.812***
Model data/ SITA Scaled to meet total imports	42.4%	0.839***
Model data/ SITA Scaled to meet total exports	40.2%	0.795***

Source: Own calculations; *** significant at the 0.01 level.

For a final step of validation, both, the SITA trade data and the trade data from the model base, are aggregated to trade flows between large geographic regions, mostly continents.[72] The results of the comparisons improve significantly, especially so for the comparison between the model data and the SITA data. The average deviation between SITA import and export data improves from 43.9% to 32.5% at the same level of data aggregation (all sugar in WSE, three years average). The correlation coefficient increases from 0.756 to 0.853. The average deviation between the model data and SITA data decreases from 71.1% to 45.6%. The correlation coefficient increases from 0.681 to 0.812. As in table 4.4, these indicators improve in almost all cases if SITA trade data is scaled to meet total imports or total exports of a country, respectively.

Interestingly, the correlation coefficients resulting from the comparison of SITA import and export data and of average SITA data and the model base data do not differ strongly from each other, but the average weighted deviations which result from the comparisons show a substantial variation, the ones resulting from the comparison of SITA import and export data being significantly lower. Both indicators do not even establish the same ordinal appraisal of the quality of data comparison in all cases. For instance, the comparison of model data with SITA data that is scaled to meet total exports on a country level in the last row of table 4.5 is evaluated a better replication of the average SITA data by the indicator of weighted average deviation than the comparisons on the two rows above, the model data compared with unscaled SITA data and the model data compared with SITA data scaled to meet total imports on a country level. By the indicator of the correlation coefficient, however, it is evaluated a worse replication than the latter two. The reason for the different behavior of both indicators is not straightforward. Both indicators measure, of course, something different. In the ideal case, where the data sets which are validated with each other are identical, there would be 0% deviation and a correlation of 1, respectively. In the other extreme case, where all trade flows which are stated to occur by one source are stated with zero by the other source and vice versa, the average deviation would be 100% and the correlation 0. All real world cases which lie between these extremes cannot be evaluated so easily. For instance, validating a data set, where all trade flows were exactly half the amount of the trade flows stated by the other data set, would result in a correlation of 1 but in a deviation of 50%. Although this example is very unlikely to occur, it shows how the indicator of the correlation coefficient can be misinterpreted. The average weighted deviation on the other hand does not have this drawback. The further away any two comparable data points will lie, the more this indicator will increase, regardless of the behavior of other data point pairs in the samples.

[72] The regions are: EU-27, Rest of Europe, Near East, Sub-Sahara Africa, North America, Central America and Caribbean, South America and Rest of Asia and Oceania.

This, together with the fact that is showed a stronger variability than the correlation coefficient, possibly renders it the more important indicator of both.

A first conclusion that can be drawn from this validation exercise is that the quality of currently available bilateral sugar trade data is rather poor.[73] Thus, even if the model were able to replicate observed trade data, as a prerequisite to that, the problem had to be addressed, how to make this trade data consistent with each other and with production and consumption data in the model. The results of this validation suggest that the adjustment which will have to be made in that case will be large.[74]

In comparison to the validation of SITA import and export data, the validation of the model base data with the average SITA data scores clearly worse where the average weighted deviation is concerned and slightly worse where the correlation coefficient is concerned. With scaling and especially with regional aggregation of trade flows this difference decreases. It remains, however, still in an order of magnitude which cannot be regarded as satisfying, and the need for a further development of the modeling approach and, as has been pointed out, a more detailed depiction of real world constraints becomes apparent.

4.1.2.3 Integration of National Policies in the Model

In this chapter the implementation of trade policies of the major players on the world sugar market are described. The chapter is structured according to countries and follows the order of chapter 2.1.2 where the policies of the countries are described first. The categories of policies covered are ad valorem tariffs, specific tariffs, producer subsidies, consumer subsidies and export subsidies. In some cases the prices which are extracted from literature contradict the production costs data which is published in the same sources or with trade policies. In those cases decisions have to be made whether to change the prices or whether to introduce "implicit" policy instruments to make the contradicting data compatible. The general rule which was followed is that if the information about the price is regarded very trustworthy, as it is the case with the data from ESIM, from the USDA and from the Japanese Government for instance, this is adopted in the model and policy instruments are introduced. Examples are implicit specific tariffs which are introduced for Romania and Bulgaria to bridge the Gap between the cif-based price from the model and the domestic price extracted

[73] Other sources of bilateral data for sugar trade (ISO, 2007; United Nations, 2007) are essentially identical to the SITA data.
[74] It would, by the way, be interesting, to perform a validation again between the trade flows in the model base and this consistent set of trade data,

from the ESIM database. For Turkey as another example, the ESIM model takes as domestic price the cif-based import price plus MFN tariff. Information from the USDA (USDA, 2007; *GAIN Report TU7030*) states producer prices and production costs which are much higher than that. Since both sources seem rather reliable, a producer subsidy is introduced to make up for the difference between the producer price by USDA and the domestic price by ESIM.

The Policies of the countries not covered in this section are extracted from ITC (2007a), UNCTAD (2007), WTO (2007), Sandrey and Vink (2007), USDA (GAIN Reports, various issues), Elobeid and Beghin (2005), Fiji Islands Revenue and Customs Authority (2007), Briner (2006) and Banse et al. (2007).

4.1.2.3.1 European Union

For the EU-25 the policy instruments are adopted from the ESIM model (Banse et al., 2007). These are a specific import tariff of € 536 per ton (MFN + additional duty under special safeguard), production quotas covering the actual amount of production (incl. C-sugar) of the base period, and variable export subsidies which sustain a price level of € 712 per ton. From 2006/07 onwards decoupled direct payments for sugar are accounted for. These are considered to be 10% coupled.[75]

The CMO reform is implemented by gradual reduction of the intervention/ reference price as the price which is sustained by granting export subsidies if the EU market is in a surplus situation. This is necessarily somewhat imprecise and arbitrary. In the base of the model it is not the intervention price which is supported by policy, but a price which is considerably higher. It cannot be said a priori what the price will be that will be sustained by the Commission as long as the price does not lead to exports exceeding the WTO limit in quantity or volume terms.[76] Furthermore, the model is unable to depict, that accumulated stocks of the EU will have to be exported which means that either exports will have to be higher or production will have to be lower than actually shown by the model in the implementation period of the CMO reform in order to achieve a balanced EU market after that period. Any results for that phase have, therefore, to be interpreted with care.

[75] This treatment of C-Sugar production in the model is stronlgy simplifying. It is an approach which is, however, also applied by other models, for instance ESIM (Banse et al., 2007). It tends to overestimate the quantity the producers are willing to produce under a certain price since the production of C-sugar is also dependent on a variety of other reasons (see Adenäuer and Heckelei, 2005). The accommodation of these issues in equilibrium models is an own field of research, though.

4.1.2.3.2 USA

The US sugar policy is difficult to predict for an outsider. Therefore, FAPRI (2006) projections for quantities at nominally constant prices are depicted in the model. This is done by calibrating the demand growth rates and by setting the marketing allotments for cane and beet producers such that the predictions are exactly met if the nominal price stays constant.[77] The internal price is set at € 518 per ton (22.9 US cents per pound, Elobeid and Beghin, 2005) The MFN tariff is set at € 292 per ton (16.21 US cent per pound, IBID.), which is prohibitive. Marketing allotments are treated as quotas and adjusted to meet the FAPRI projections of production. NAFTA and CAFTA market access are phased in as scheduled and raw and refined sugar TRQs are adjusted in order to meet the balance gap between US demand and supply.

4.1.2.3.3 Brazil

The only policy modeled for Brazil is the MFN import tariff and the preferential import tariffs for some Latin American countries. This is, however, without any consequences as Brazil does under no scenario import sugar. The ethanol policy of Brazil is not accounted for explicitly. However, supply functions are scaled downwards in 2006/07 compared to the base period to meet the FAPRI projections. The increase in opportunity costs for sugar production which is simulated by that can in part be seen to implicitly account for the ethanol use of sugar cane (and other crops).

4.1.2.3.4 Australia

No policies are modeled for Australia.

4.1.2.3.5 Thailand

The policies modeled for Thailand are a 65% ad valorem tariff (Imports do not take place either in reality or in the model and are unlikely to occur under any scenario. The TRQ and above quota tariff are, therefore, not modeled). The development of the domestic sales quota (Quota A) is hard to predict. It is accounted for by a tax equivalent which lifts internal prices in the model to the levels observed in reality. This policy leads over the whole projection period to a price level somewhat above world market prices which is probably realistic.

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[76] These limits are 1.273 million tons WSE and € 499 million respectively. Utilizing fully both limits means a price of € 392 above the world market price can be sustained (volume divided by quantity). With world market price levels of around € 200 this corresponds to an internal price level of slightly less than € 600. It is, however clear, that the price in the EU will be lower after full implementation. The volume limit of subsidized exports will, thus become irrelevant in the medium run.

[77] FAPRI does not assume a change of the loan rate which effectively establishes the internal price. Technical progress shifters of supply have been set such that the marketing allotments are always filled.

4.1.2.3.6 Guatemala

For imports in Guatemala a 20% MFN tariff and duty-free market access for member countries of the Central American Common Market (CACM) is modeled. Imports do, however, not occur.

4.1.2.3.7 Cuba

Market policies for a planned economy such as Cuba are difficult to model, if at all. The approach which is followed here is that the production costs for Cuba are extracted from Illovo (2006) and a producer subsidy is modeled to bridge the gap between the (export based) market price and the costs from literature. An abolishment of that subsidy in the model would correspond to a privatization of sugar producing enterprises.

4.1.2.3.8 Colombia

The only policy modeled for Columbia is the import tariff of 20% and the tariff exemptions for Andean Community member states. The adjustments of duty for prices outside the price band are ignored, since this policy addresses price fluctuations which do not occur in a non-stochastic model such as the one used here. Furthermore, Columbia as a single country and the Andean Community as a whole are net exporters.

4.1.2.3.9 South Africa

The South African trade policies, a specific tariff of ZAR 233 (South African Rand, ~ € 30) per ton, cannot explain the high internal price level (€ 441 per ton) which is reported in numerous trustworthy sources. To account for the high price level, an ad valorem tariff equivalent to all suppliers (including South Africans themselves, which produce and export under world market conditions) is introduced in the model in addition to the € 30 per ton which was applied officially in the base period of the model. This tariff equivalent is supposed to depict the distortions introduced by the internal marketing system, which is apparently also effective in keeping foreign suppliers out of the market. TRQ limited market access for SADC countries is implemented as described in section 2.1.2.9., treating 2004/05 as marketing year one. However, all countries but Zimbabwe and Zambia have either no surplus to export or have more advantageous export opportunities, such as EU sugar protocol quotas. The overall quota for SADC countries to the SACU market is therefore divided between those two countries.

4.1.2.3.10 Russian Federation

For the base period a weighted average of the import tariff applied by Russia converted in current € is calculated with € 146. Since September 2005 the tariff is not adjusted anymore and stays at US$ 140 per ton (~ € 114). For the projections of the model it is assumed that the nominal level of the tariff in € stays constant.

4.1.2.3.11 China

As for Cuba, it is difficult to model market policy effects on a sector which is to a large extent government controlled. For China only the trade policies mentioned in chapter 2.1.2.11 are modeled and the internal price is determined in the calibration run.

4.1.2.3.12 India

India's sugar policy parameters are adapted frequently and rather unpredictably. Only the trade policies are modeled which are a 60% ad valorem tariff plus a countervailing duty of 850 Rs. (~ € 15) which also has to be paid for domestically marketed sugar. An export ('transport') subsidy for exported sugar of 140 Rs. Per ton (~ € 3) is also accounted for in the model.

4.1.2.3.13 Japan

The Japanese import policy is difficult to depict since it is unclear how the licensing system works. Another difficulty is the high gap between domestic and international prices mentioned in 2.1.2.13. As a starting point for depicting Japanese policies the domestic prices quoted by ALIC (2007) for the base period was chosen and converted in real 2005 €. This price was around ¥ 133 per kg (~ € 984 per ton). The difference between the cif based import price and the average resale price was modeled as a specific tariff equivalent. The gap between that cif duty-paid price and the domestic wholesale price, accounting for the abnormally high profit and wholesale margins set as a specific tariff. A preferential TRQ is modeled only for Fiji to account for the observed imports which cannot be explained otherwise. TRQs for the remaining imports are not modeled as the model framework does not allow for non-country specific TRQs. They are regarded as entering under a first come-first serve TRQ. For projections, it must be assumed, that the TRQs are adjusted over time to fill the gap between domestic supply and demand at desired prices, which is implicitly accounted for by the tariff equivalent.

4.2 Model Analysis

4.2.1 Description of Scenarios

In this study, four scenarios are calculated with the model described above. The scenarios and the assumptions made are described in this section, whereas in the next section, 4.2, the results will be presented and discussed. The projection horizon for all scenarios shall be 2015/16.

4.2.1.1 Scenario 1: Baseline Scenario

The first scenario to be calculated with the SPE model established for this study is a baseline scenario which will serve as a benchmark for the other three simulations. Trade and domestic sugar policies are assumed to be continued, unless changes are already decided. These changes are on the part of the EU the implementation of the 2006 reform of the EU's CMO for sugar, the accession of Bulgaria and Romania including the implementation of import quotas for their suppliers previous to accession, phasing in of unlimited market access for LDCs and according reduction and finally abolition of the SPS quotas, and reallocation of Protocol quotas of countries which are unable to fill them to other participant countries of the sugar protocol. On the part of the USA, NAFTA market access for Mexico and CAFTA-DR market access for sugar from Central American countries and the Dominican Republic is phased in as planned. Remaining sugar TRQs are adjusted in order to meet projected imports by FAPRI.

The BDI, and thus ocean freight rates for sugar, moved upwards in 2007 (see figure 2-3). This move is captured for the baseline scenario and all others, by estimating ocean freight rates for 2006/07 as described in 4.1.2.2.3 with the average BDI of 2006/07 as explaining variable. In the remaining years of the projection horizon the BDI is assumed to return linearly to its average level of the base period.

Against the results of this baseline scenario the results of the following three counterfactual scenarios are compared to investigate the projected effect of the policy changes on production, consumption, prices and trade flows.

4.2.1.2 Scenario 2: WTO Agreement

The first counterfactual Scenario, referred to as DOHA, simulates the implementation of a possible WTO agreement. As a reference for how such an agreement could be shaped, the proposal of Chairman Falconer in July 2007 is taken. The suggestions of the Falconer proposal in terms of market access are summarized in table 4-3 below.

Table 4-6: Proposed Formula for Agricultural Tariff Cuts

Industrialized countries		Developing Countries	
Current tariff in ad valorem equivalents	Tariff reduction	Current tariff in ad valorem equivalents	Tariff reduction
0-20%	48-50%	0-30%	32-33%
20-50%	55-60%	30-80%	37-40%
50-75%	62-65%	80-130%	41-43%
> 75%	66-73%	> 130%	44-49%

Source: Agra-Europe Weekly (2007).

Tariff reductions would happen in four categories, so-called bands. The band with the highest tariffs in ad valorem equivalents would face the strongest tariff cuts. The widths of the bands are different between developed and developing countries as are the proposed tariff cuts. The tariffs of industrialized countries falling into the highest band are those above an ad valorem equivalent of 75%. These would have to be cut by between 66% and 73%. The highest band for developing countries on the other hand would comprise only those tariffs exceeding an ad valorem equivalent of 130% and proposed reductions thereof would be between 44% and 49%. The sugar tariffs of as well the EU as the USA would fall in the highest band and are thus subject of reductions of 70%.[78] The same is true for the sugar tariffs of most industrialized countries. Among the group of developing countries, only Turkey and Panama fall in the highest band.[79] A number of other developing countries, among them the big importers China and India have bound their tariffs in the UR and with accession respectively so high above the applied levels that no reductions need to be done.[80]

Falconer suggests different options for the future of the special safeguard clause. For this study it is assumed that it is not used for sugar markets of developed countries anymore, in particular the EU. It is furthermore assumed, that no country declares sugar as a sensitive product, which would allow for smaller tariff cuts on the one hand, but require the applying country to open additional TRQs, or as a special product. Reduction commitments for domestic support suggested by the Falconer Proposal are not accounted for in the scenario. The

[78] For the implementation of tariff reductions in the model the arithmetic mean of the proposed range is used.

[79] Some other countries fell into the highest band with their bindings, their applied tariffs were, however, not affected by reduction commitments for the bound tariffs. A special case is Morocco, which applies currently an ad valorem tariff plus a variable duty. Since the model is not stochastic, the variable duty is modeled as a specific tariff. Both measures together bring Morocco in the highest band for developing countries and its tariff are in the DOHA scenario modeled as the bound ad valorem equivalent minus the reduction commitments.

[80] In cases where countries operated preferential tariffs for other countries or groups of countries, these are in the model reduced by the same percentages as the MFN tariffs.

only country for which domestic support is modelled explicitly is the EU, where the scale is minor. What remains is, of course, the elimination of all export subsidies.

Some countries, especially Japan and South Africa, operate sugar policies which are highly intransparent and actually not in line with Uruguay Round commitments (see, e.g. Van der Mensbrugghe et al., 2003). The effects these policies have are accounted for in the Base period by ad valorem tariff equivalents. For the simulation of the DOHA scenario, the policies applied by these two countries are reduced to their UR bound tariffs minus the necessary reduction. While in the case of South Africa this affects merely the internal price level and the quota rents of some preferential importers from SADC, in the case of Japan the producer incentive price is also affected massively.[81]

4.2.1.3 Scenario 3: EU Liberalization

The second counterfactual scenario simulates a complete liberalization of all EU sugar policies. All policy measures such as production quotas, tariffs, TRQs and export subsidies are abolished. The only policy measure which is retained is the decoupled direct payments.[82]

4.2.1.4 Scenario 4: Full Liberalization

The last scenario is a full liberalization of all sugar market and domestic polices by all countries in the model.

4.2.1.5 Sensitivity Analyses

The results of all equilibrium model studies depend crucially on assumptions and parameters for which the empirical foundation is often rather weak. The study at hand is no exemption from this rule. To investigate the extend to which results of policy changes might be over- or underestimated as a consequence of misspecification of parameters and assumptions, a series of sensitivity analysis is performed.

The parameters which are regarded crucial are the supply elasticities of sugar and the BDI. Thus, the baseline scenario and the full liberalization scenario are calculated again under the assumption of

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[81] The complete list of policy changes introduced can be seen in the Annex tables.

1. A permanent increase of the BDI to its 2007 peak[83]
2. A doubling of all supply elasticities
3. A halving of all supply elasticities[84]

4.2.2 Results and Discussion[85]

4.2.2.1 Scenario 1: Baseline Scenario

Table 4-4 shows the results of the baseline scenario for supply, demand and domestic wholesale prices for the most important players of the world sugar market and for the world as a whole. Global production grows by 14% to 151 million tons. The only country in the table that reduces its production is the EU, which is due to the implementation of 2006 reform. The world market price increases by roughly 12% and the domestic prices of countries linked to the world market increase by about the same percentage. The prices of the EU and the USA decline. For the EU this is largely due to policy changes, for the USA it is the result of merely deflation of nominal (institutional) prices.

Table 4-7: Results of the Baseline Scenario in Million Metric Tons (MT) WSE and €/ton [a]

2015/16	Supply		Demand		Price	
World	151.0	(14%)	151.0	(14%)	207	(12%)
EU-27	16.3	(-15%)	19.5	(8%)	426	(-40%)
USA	7.1	(3%)	8.8	(3%)	414	(-20%)
BRA	31.4	(23%)	11.3	(16%)	196	(13%)
AUS	5.9	(20%)	1.2	(12%)	212	(12%)
THA	6.5	(33%)	2.5	(20%)	246	(11%)
GUA	1.9	(10%)	0.7	(26%)	196	(13%)
CUB	1.7	(12%)	0.7	(7%)	198	(13%)
COL	2.9	(27%)	1.8	(23%)	194	(12%)
SAF	2.5	(21%)	1.6	(10%)	517	(13%)
RUS	2.4	(12%)	6.1	(3%)	359	(0%)
CHN	10.0	(12%)	11.9	(13%)	320	(9%)
IND	22.0	(25%)	22.0	(21%)	427	(8%)
JAP	1.0	(20%)	2.2	(1%)	1,023	(4%)
Other	39.4	(16%)	60.8	(17%)	-	-

Source: Own simulations; [a] Numbers in brackets are changes compared to the base period.

Table 4-5 shows the results for the EU domestic Market. The 2006 reform is implemented in the model by fixing quotas to the most recent published level (European Union,

[82] The assumed allocation effectiveness of these direct payments, which is adopted from the ESIM model (Banse et al., 2007), is 20%, which makes their effect on production rather unimportant.
[83] In early October 2007 the BDI had passed beyond 10,000 whereas its average in former years (and the base period of the model) was around 4,000.
[84] Note that only the isoelastic supply functions are affected by 2 & 3.

2006, Council Regulation (EC) 2011/2006, *Official Journal* (*OJ) L 384*, pp. 1-7), the (exogenously determined) abolishment of sugar production in Ireland, Latvia and Slovenia (Bureau et al., 2007), the reduction of the reference price as the price which is supported by paying export subsidies for the gap to the world market price and finally the effective prohibition of C-sugar production. The model simulates that these measures are more than sufficient to achieve a balanced EU market in the medium run. At a domestic wholesale price of € 426 per ton of white sugar the EU production will together with preferential imports achieve market equilibrium without any subsidized exports.[86] Of those member states which continue to produce, all southern member states do not manage to fill their quota while all northern member states as well as those which acceded in 2004 fill their quota. The only exemption is Finland.

Table 4-8: EU Results of the Baseline Scenario in Million MT WSE [a]

Production in Member States in 2015/16					
AT	0.3873	(-9%)	LT	0.1030	(-16%)
BE	0.8198	(-10%)	LV	0	(-100%)
CZ	0.4549	(-13%)	NL	0.8646	(-0%)
DK	0.4207	(-14%)	PL	1.6719	(-12%)
ES	0.7533	(-25%)	PT	0.0402	(-44%)
FI	0.1082	(-26%)	SI	0	(-100%)
FR	4.0325	(-4%)	SK	0.1849	(-18%)
GE	3.6555	(-7%)	SW	0.3257	(-18%)
GR	0.1464	(-53%)	UK	1.1386	(-12%)
HU	0.4017	(-14%)	BUL	0.0029	(21%)
IE	0	(-100%)	ROM	0.0435	(7%)
IT	0.7251	(-52%)	Total	16.2807	(-15%)
Imports				3.2427	(25%)
Subsidized Exports				0.0	(-100%)

Source: Own simulations; a Numbers in brackets are changes compared to the base period.

Table 4-6 shows the results of the baseline scenario for preferential sugar imports by the EU-27 under different preferential import schemes. Total imports increase to roughly 3.2 million tons. In the base period they had been 2.6 million tons, 700 thousand tons of which were, however, imports of Romania and Bulgaria previous to their accession that did not take place under any of the preferential schemes mentioned in the table.

[85] All results of supply, demand, consumer and producer prices as well as bilateral trade flows are displayed in the annex tables.
[86] This price is much above the envisaged reference price level, which is deflated to roughly € 323 in 2015/16. Subsidized exports, though legally still possible up to the quantitative limit that was bound in the UR, do not take place, since export subsidies will only bridge the gap between the fob price and the reference price.

Due to the reduced internal market price in the EU, for some countries it is not advantageous anymore to export to the EU. ACP quotas of countries that are unable to fill them are redistributed to other ACP countries who participate in the sugar protocol, thus overall imports from these countries stay more or less constant. Imports under the Balkans Initiative decrease by 97% since for the largest supplier, Serbia, it is not profitable anymore to supply sugar to the EU and the country instead replaces former imports to its domestic market.[87] Imports from LDCs under EBA increase after phasing in of unrestricted market access by large percentages to an overall amount of 1.3 million tons. This is well below the figures given by the studies cited in section 2.1.2.1, but still higher than the figures projected by Van Berkum et al. (2005). Some LDCs which did deliver under preferential quotas during the phasing in of EBA do not export anymore after the reduction of EU prices. Ethiopia with roughly 350 thousand tons is the largest exporter under EBA. Imports under CXL stay constant except for Brazil who is attributed new quotas due to the accession of Bulgaria and Romania in 2007 which it fills completely. Imports under SPS completely disappear as the imports under EBA increase.

[87] The scheme also provides a TRQ to Bosnia-Herzegovina, which, however, due to the sources used for the Database, does not produce sugar.

Table 4-9: Results of the Baseline Scenario for Preferential Imports in the EU-27 in thousand MT WSE [a]

2015/16	**ACP**			**BALKANS**			**EBA**			**CXL**			**SPS**			**Total**		
	Base	Baseline		Base	Baseline		Base	Baseline		Base	Baseline		Base	Baseline		Base	Baseline	
ALB				1.3	1.3	-										1.3	1.3	-
AUS										9.1	9.1	-				9.1	9.1	-
BAN							0.3	133.0	(44,233%)							0.3	133	(44,233%)
BAR	32.3	29.7	(-8%)													32.3	29.7	(-8%)
BEL	39.9	44.3	(11%)										2.0	0	(-100%)	41.9	44.3	(6%)
BEN							3.8	3.4	(-11%)							3.8	3.4	(-11%)
BRA										22.0	508.1	(2,210%)				22	508.1	(2,210%)
BUR							8.0	0	(-100%)							8	0	(-100%)
CDR							11.7	66.4	(468%)							11.7	66.4	(468%)
CON	10.2	11.3	(11%)										1.7	0	(-100%)	11.9	11.3	(-5%)
COT	10.2	11.3	(11%)										10.0	0	(-100%)	20.2	11.3	(-44%)
CUB										54.3	54.3	-				54.3	54.3	-
ETH							13.8	354.0	(2, 465%)							13.8	354	(2,465%)
FIJ	167.7	186.0	(11%)										7.0	0	(-100%)	174.7	186	(6%)
GAB								22.4	(New flow)							0	22.4	(New flow)
GUA										3.7	3.7	-				3.7	3.7	(0%)
GUI								27.5	(New flow)							0	27.5	(New flow)
GUY	155.0	171.9	(11%)										8.0	0	(-100%)	163	171.9	(5%)
IND	9.9		(-100%)													9.9	0	(-100%)
JAM	118.6	135.3	(14%)										6.4	0	(-100%)	125	135.3	(8%)
KEN	10	0	(-100%)										10.5	0	(-100%)	20.5	0	(-100%)
MAD	10.8	12.0	(11%)					13.8	(New flow)				1.7	0	(-100%)	12.5	25.8	(106%)
MAL	20.8	23.1	(11%)				2.6	84.1	(3,135%)				10.0	0	(-100%)	33.4	107.2	(221%)
MAU	491.0	468.0	(-5%)										13.8	0	(-100%)	504.8	468	(-7%)
MOZ	12.0	13.3	(11%)				27.6	261.0	(846%)							39.6	274.3	(593%)
NEP							9.0	0	(-100%)							9	0	(-100%)
REU				5.3	5.3	-										5.3	5.3	-
SEN								96.7	(New flow)							0	96.7	(New flow)
SER				225.0	0	(-100%)										225	0	(-100%)
SRL								6.1	(New flow)							0	6.1	(New flow)
STK	15.6	17.2	(10%)													15.6	17.2	(10%)
SUD							16.4	181.3	(1,005%)							16.4	181.3	(1005%)
SWA	118.2	131.1	(11%)										30.0	0	(-100%)	148.2	131.1	(-12%)
TAN	10.1	0	(-100%)				1.7	0	(-100%)				1.7	0	(-100%)	13.5	0	(-100%)
TRI	29.7	27.3	(-8%)													29.7	27.3	(-8%)
ZAM	14.4	16.0	(11%)				9.2	87.4	(850%)				11.9	0	(-100%)	35.5	103.4	(191%)
ZIM	23.4	26.0	(11%)										25.0	0	(-100%)	48.4	26	(-46%)
Total	**1,299.8**	**1,323.8**	**(2%)**	**231.6**	**6.6**	**(-97%)**	**104.1**	**1,337.1**	**(1,184%)**	**89.1**	**575.2**	**(546%)**		**0**	**(-100%)**	**1864.3**	**3242.7**	**(74%)**

Source: Own simulations; [a] Numbers in brackets are changes compared to the base period.

Table 4-7 shows the imports of the USA under different preferential TRQ schemes. CAFTA and NAFTA are assumed to be fully implemented. Whereas all CAFTA-DR quotas are filled some countries do not fill their quotas under the traditional TRQ system of the USA. This is first of all Mexico, not exporting at all anymore, which is especially interesting having in mind the fears that fully phased in Market Access under NAFTA would put US markets under pressure. Given its high tariffs and the deflation of the US price level, it becomes more advantageous for Mexican producers to market their sugar domestically. Other countries, most of which are African LDCs, ship their available production to the EU rather than to the US after being granted extended access to that market. TRQs of other quota holders are increased by about 20% to keep the overall level of imports constant.

Table 4-10: Results of the Baseline Scenario for US Preferential Imports in thousand MT WSE [a]

2015/16	TRQs (incl. NAFTA)		CAFTA-DR	
ARG	84.1	(20%)		
AUS	162.5	(21%)		
BEL	21.6	(21%)		
BOL	15.8	(22%)		
BRA	283.6	(21%)		
CAN	38.3	(20%)		
COL	47.0	(21%)		
CON	6.7			
COR	29.4	(21%)	11.9	(New flow)
COT	6.7			
DOM	275.3	(21%)	10.9	(New flow)
ECU	21.6	(21%)		
ELS	50.9	(21%)	29.7	(New flow)
FIJ	14.1	(21%)		
GUA	93.7	(20%)	40.2	(New flow)
GUY	23.4	(21%)		
HON	19.5	(20%)	8.7	(New flow)
IND		(-100%)		
JAM	0.6	(-93%)		
MAD		(-100%)		
MAL		(-100%)		
MEX		(-100%)		
MOZ		(-100%)		
NIC	41.1	(21%)	23.9	(New flow)
PAN	22.2	(-46%)		
PAR		(-100%)		
PER	80.2	(21%)		
PHI	105.4	(-48%)		
PNG	6.7			
REA	15.1	(20%)		
SAF	44.8	(20%)		
STK		(-100%)		
SWA	31.3	(21%)		
THA	27.3	(20%)		
URU	6.7			
ZIM	23.4	(21%)		
Total	1,599.0	(-3%)	125.3	(New scheme)

Source: Own simulations; [a] Numbers in brackets are changes compared to the base period.

4.2.2.2 Scenario 2: WTO Agreement

In table 4-8 the results of the WTO scenario for production, consumption and prices of the most important countries are presented. The extended market access to formerly highly protected industrialized countries' markets lifts the world market price by 14% to € 236 in comparison to the baseline scenario. The overall volume of the world market is almost unaffected, but among countries a sizeable reallocation of production takes place. The high protected countries EU, USA and Japan see significant reductions of production.

The EU loses the least in terms of market share, which is due to the 2006 reform which anticipated many of the liberalizations which would otherwise have become due after the ratification of the WTO agreement. However, after the reduction of its tariffs including the abolishment of the SSG, MFN imports take place on a large scale (see below) for probably the first time in the history of the CMO for sugar.

In the USA, production falls by 27%. This is mainly made up for by a reduction of beet production, which falls by 42% while cane production merely goes down by 8%. The USA also becomes a major sugar importer on a MFN base.

The most tremendous changes are faced by Japan, though, where sugar production comes completely to an end. This outcome is, however, contingent upon whether the WTO agreement will, as is assumed here, bring about a tariffication of Japan's import policies and a reduction of the tariff from the levels that were bound in the UR.

The highest increase in production in absolute as well as in relative terms takes place in Brazil, which increases its production by 9%. Other competitive exporters increase their production by between 3% and 7%. One other notable result is the strong price decrease in South Africa, which refers to the consumer price only, however (see sections 2.1.2.9 and 4.1.2.3.9). That decreases by 56% after implementing the agreed tariff cuts.[88] The producer price (not displayed in the table) was the fob-based world market price already before. It increases thus by just 11% relative to the baseline scenario. For India, production, consumption and prices are not at all effected. This is, since its tariffs are bound at a much higher level than the applied ones and the applied tariffs are prohibitive with a significant amount of "water" in them.

[88] This result is again contingent on assumptions. These are, that the internal marketing system is liberalized as well, which lets consumers in South Africa (and SACU) buy sugar at world market prices since the region is a surplus producer. This assumption is, of course, arbitrary, as any other assumption on how the internal marketing system is adapted to cope with the downward pressure on prices resulting from the tariff cut would be. Assuming in contrast that the marketing system would not be liberalized, but the prices would be supported at the highest level possible, i.e. the cif-duty paid import price, would lift prices in South Africa to € 356 and lower consumption by 4% in all of SACU. The effect on the world market price is with less than € 0.30 minor, though.

Table 4-11: Results of the WTO Scenario in Million MT WSE and €/ton [a]

2015/16	Supply		Demand		Price	
World	151.1	(0%)	151.1	(0%)	236	(14%)
EU-27	15.4	(-6%)	19.7	(1%)	380	(-11%)
USA	5.2	(-27%)	8.9	(1%)	350	(-15%)
BRA	34.2	(9%)	11.2	(-1%)	218	(12%)
AUS	6.3	(7%)	1.2	(-1%)	235	(11%)
THA	6.8	(3%)	2.4	(-1%)	272	(11%)
GUA	2.0	(4%)	0.7	(-1%)	221	(13%)
CUB	1.8	(2%)	0.7	(-1%)	223	(13%)
COL	3.1	(5%)	1.7	(-1%)	219	(13%)
SAF	2.6	(4%)	1.7	(9%)	227	(-56%)
RUS	2.5	(4%)	6.1	(0%)	381	(6%)
CHN	10.2	(3%)	11.8	(-1%)	347	(9%)
IND	22.0	(0%)	22.0	(0%)	427	(0%)
JAP	0.0	(-100%)	2.4	(7%)	426	(-58%)
Other	39.1	(-1%)	60.6	(0%)	-	-

Source: Own simulations; [a] Numbers in brackets are changes compared to the baseline scenario.

The reduction of the bound tariff for white sugar by almost 70% in the EU reduces the effective protection significantly to a non prohibitive level and thus ends the isolation of EU producers from world market price movements. The wholesale price declines to € 380 per ton which is still above the reference price level of € 323. While some of the countries which filled their quotas in the baseline scenario continue to do so at the reduced price others do not, as can be seen in table 4-9. Those countries which did not fill their quotas already in the baseline reduce their production further. No country ceases production, but some reduce it so strongly that the small remaining quantities may not be sustainable for a processing firm. Overall production is projected to fall by 6% to 15.4 million tons. Imports increase by 35% to 4.4 million tons, 1.9 million of which are MFN imports coming entirely from Brazil. As in the baseline scenario, subsidized exports do not take place anymore.

Table 4-12: EU Results of the WTO Scenario in Million MT WSE [a]

Production in Member States in 2015/16					
AT	0.3873		LT	0.0804	(-22%)
BE	0.8198		LV	0	
CZ	0.4549		NL	0.8646	
DK	0.3559	(-15%)	PL	1.6719	
ES	0.4844	(-36%)	PT	0.0205	(-49%)
FI	0.0792	(-27%)	SI	0	
FR	4.0325		SK	0.1356	(-27%)
GE	3.6555		SW	0.3257	
GR	0.0551	(-62%)	UK	1.1386	
HU	0.4017		BUL	0.0024	(-17%)
IE			ROM	0.0352	(-19%)
IT	0.3518	(-51%)	Total	15.353	(-6%)
Imports				4.3653	(35%)
Subsidized Exports				0.0	

Source: Own simulations; [a] Numbers in brackets are changes compared to the baseline scenario.

Table 4-10 shows the results for preferential trade flows to the EU. In total they decrease by 24% from 3.2 million tons in the baseline scenario to 2.5 million tons after implementation of the WTO Agreement. A number of ACP countries do not fill their quotas anymore, which are subsequently reallocated to other protocol members. Since imports under the protocol are subject to a refinery aid, they are more profitable than under EBA. Hence, some LDCs, Malawi, Mozambique and Zambia, decrease their deliveries under EBA, which does not mean, however, that their market access has declined. Other LDCs decrease or cease their exports due to the lower prices. The trade flows under the Balkans Initiative and under CXL stay constant.

Table 4-13: Results of the WTO Scenario for Preferential Imports in the EU-27 in thousand MT WSE [a]

2015/16	ACP		BALKANS	EBA		CXL
ALB			1.3			
AUS						9.1
BAN				0	(-100%)	
BAR	10.3	(-65%)				
BEL	68.7	(55%)				
BEN				0	(-100%)	
BRA						508.1
BUR						
CDR				0	(-100%)	
CON		(-100%)				
COT		(-100%)				
CUB						54.3
ETH				337.3	(-5%)	
FIJ	218.7	(18%)				
GAB				0	(-100%)	
GUA						3.7
GUI				0	(-100%)	
GUY	266.7	(55%)				
IND						
JAM	4.0	(-97%)				
KEN						
MAD	0	(-100%)		0	(-100%)	
MAL	35.8	(55%)		52.4	(-38%)	
MAU	402.1	(-14%)				
MOZ	20.6	(55%)		85.6	(-67%)	
NEP						
REU			5.3			
SEN				0	(-100%)	
SER						
SRL				0	(-100%)	
STK	12.9	(-25%)				
SUD				0	(-100%)	
SWA	203.4	(55%)				
TAN						
TRI	0	(-100%)				
ZAM	24.8	(55%)		98.1	(12%)	
ZIM	40.3	(55%)				
Total	1,308.3	(-1%)	6.6	573.4	(-57%)	575.2

Source: Own simulations; [a] Numbers in brackets are changes compared to the baseline scenario.

In Table 4-11 the preferential imports of the USA are presented. As in the EU, the US domestic price level for sugar is affected by the WTO agreement which makes their MFN tariffs non prohibitive. The domestic price declines from € 414 in the baseline scenario to € 350 per ton under the tariff cuts (see table 4-8). MFN imports of a total of 2 million tons enter from Brazil, Colombia, Costa Rica, Honduras and the Rest of the Caribbean in declining order.[89]

Of the traditional preferential importers some decrease or end their exports to the USA. Two forces are responsible for that. These are the declining preferential margin, of course, but also an increased TRQ for the EU market in some cases which is more profitable to fill. The TRQs of other quota holders are increased.[90] In the case of the Dominican Republic that leads the country to not filling its CAFTA-DR quota anymore in contrast to all other countries participating in this agreement.

[89] This result is depending on the assumption that the USA will retain its trade embargo against Cuba. Otherwise, about 600 thousand tons would be imported from Cuba.
[90] It is, of course, questionable whether the USA will increase those quotas which actually meant to provide for the minimum and current access commitments from the UR, when MFN imports enter its market on a large scale. However, for this study it is assumed.

Table 4-14: Results of the WTO Scenario for US Preferential Imports in thousand MT WSE [a]

2015/16	TRQs (incl. NAFTA)		CAFTA-DR	
ARG	117.3	(39%)		
AUS	226.6	(39%)		
BEL	18.5	(-14%)		
BOL	13.5	(-15%)		
BRA	395.4	(39%)		
CAN	32.8	(-14%)		
COL	65.6	(40%)		
CON	0	(-100%)		
COR	41.0	(39%)	11.9	
COT	0	(-100%)		
DOM	141.5	(-49%)	9.9	(-9%)
ECU	30.1	(39%)		
ELS	70.9	(39%)	29.7	
FIJ	0	(-100%)		
GUA	130.6	(39%)	40.2	
GUY	0	(-100%)		
HON	27.2	(39%)	8.7	
IND				
JAM	0	(-100%)		
MAD				
MAL				
MEX				
MOZ				
NIC	57.2	(39%)	23.9	
PAN	9.5	(-57%)		
PAR				
PER	68.5	(-15%)		
PHI		(-100%)		
PNG	6.7			
REA		(-100%)		
SAF	62.5	(40%)		
STK				
SWA	43.6	(39%)		
THA	38.1	(40%)		
URU	0	(-100%)		
ZIM	0	(-100%)		
Total	1,597.1	(-0%)	124.3	(-1%)

Source: Own simulations; [a] Numbers in brackets are changes compared to the baseline scenario.

4.2.2.3 Scenario 3: EU Liberalization

Table 4-12 shows the model results of a unilateral liberalization on the part of the EU on global production, consumption and prices. Relative to the baseline scenario, world production decreases by 1%. The world market price increases by 23% to € 255 per ton. It is interesting to note that the full liberalization of the EU alone has a stronger effect on world market prices than partial liberalization by all countries under a possible Doha Round Agreement, which led to a world market price increase of merely 14% to

€ 236 per ton. The production of competitive exporters increases by different percentages. The strongest increase can be observed for Brazil with 19% to 37.3 million tons. India and the US do not react at all to the policy changes in the EU.[91] This is because their markets are isolated from what happens on the world market by prohibitive tariffs.

Table 4-15: Results of the EU Liberalization Scenario in Million MT WSE and €/ton [a]

2015/16	Supply		Demand		Price	
World	150.2	(-1%)	150.2	(-1%)	255	(23%)
EU-27	5.0	(-69%)	20.1	(3%)	306	(-28%)
USA	7.1	(0%)	8.8	(0%)	414	(0%)
BRA	37.3	(19%)	11.1	(-2%)	244	(25%)
AUS	6.6	(13%)	1.2	(-2%)	255	(20%)
THA	6.9	(6%)	2.4	(-2%)	292	(19%)
GUA	2.1	(8%)	0.7	(-2%)	242	(23%)
CUB	1.8	(4%)	0.7	(-2%)	244	(23%)
COL	3.2	(8%)	1.7	(-2%)	241	(25%)
SAF	2.7	(8%)	1.5	(-2%)	642	(24%)
RUS	2.6	(9%)	6.0	(-1%)	407	(14%)
CHN	10.4	(5%)	11.8	(-1%)	368	(15%)
IND	22.0	(0%)	22.0	(0%)	427	(0%)
JAP	1.3	(31%)	2.2	(-1%)	1158	(13%)
Other	41.1	(4%)	60.0	(-1%)	-	-

Source: Own simulations; [a] Numbers in brackets are changes compared to the baseline scenario.

In table 4-13 it can be seen that the production in all EU-27 member states is affected by the unilateral liberalization of its sugar market policies which lowers the internal price to € 306 per ton.[92] No member state is able to fill its quota anymore. All southern member states abandon sugar production. All others reduce their production significantly. The total supply in the EU goes down by 69% to 5 million tons and imports rise almost fourfold to 15.3 million tons. 13.6 million tons of these imports come from Brazil, about 700 thousand tons from Eastern Europe and the remainder form several Caribbean countries. Preferential imports take, of course, not place anymore. Former preferential suppliers ship their products to other destinations with preferential access, which are, however, limited and supply the regional market, i.e. mainly Sub-Saharan Africa. Some countries also reduce their produc-

[91] The production increase in Japan is actually the highest in relative terms. This result has, however, to be treated with caution. The difference between the import price and the internal price which cannot be explained by any policies is modeled by an ad valorem tariff equivalent (see sections 2.1.2.13 and 4.1.2.3.13). This means that higher world market prices translate into an even higher gap to domestic prices. Whether this will happen in reality is highly questionable, though. Together with the functional form of the Japanese supply curve in the model, which has a higher elasticity than an isoelastic curve this leads to rather strong production increases. Fortunately, this increase moves in a range in which it does not affect the further results of the model significantly. Alternatively, the gap could be accounted for by a specific tariff equivalent. This would, however, result in a deflation of this gap over time, which is rather unrealistic.

[92] This is only 5% below the reference price of € 323.

tion, on average by 2%.[93] The most affected countries are Barbados and St. Kitts and Nevis where production decreases by 13% and 11% respectively. Some countries, however, even increase their production as their prospects on the world market have increased.

As part of the liberalization, the EU abolishes also all export subsidies, which have, however, no effect in the baseline scenario already. Subsidized exports of EU sugar take thus not place anymore under any scenario. One of the interesting results of this scenario is, however, that the EU turned to a MFN exporter of sugar. It exports some 250 thousand tons to Switzerland for which it has a comparative advantage due to transportation costs.

Table 4-16: EU Results of the EU Liberalization Scenario in Million MT WSE [a]

Production in Member States in 2015/16					
AT	0.1272	(-67%)	LT	0.0227	(-78%)
BE	0.1964	(-76%)	LV	0	
CZ	0.2485	(-45%)	NL	0.2791	(-68%)
DK	0.0081	(-98%)	PL	0.5647	(-66%)
ES	0	(-100%)	PT	0	(-100%)
FI	0.0238	(-78%)	SI	0	
FR	1.3093	(-68%)	SK	0.0413	(-78%)
GE	1.0839	(-70%)	SW	0.2619	(-20%)
GR	0	(-100%)	UK	0.6808	(-40%)
HU	0.1772	(-56%)	BUL	0.0015	(-48%)
IE	0		ROM	0.0205	(-53%)
IT	0	(-100%)	Total	5.0469	(-69%)
Imports				15.3031	(372%)
Subsidized Exports				0.0	

Source: Own simulations; [a] Numbers in brackets are changes compared to the baseline scenario.

In table 4-12 it became clear that supply, demand and prices on the US market are not affected by a unilateral liberalization of the EU. There are, however, some effects on the US market since the markets of its preferential import quota holders are affected. These impacts are threefold. First, some countries lose their preferential margin on the EU market and thus tend to fill their TRQs on the US market which were formerly under utilized. The only country going that way is Jamaica, which as can be seen in table 4-14 increases its imports to the upper limit of the quota which has due to several years of under delivery been cut to a minimum boatload. Secondly, some countries benefit from a higher world market price and ship their production to other countries or use it to substitute former imports on their domestic market. These are Congo (Republic (R.)) and Côte d'Ivoire. Third, the remaining quota

[93] Arithmetic mean of ACP protocol members and LDCs which exported to the EU in the baseline scenario.

holders are affected by a reallocation of quotas to keep the overall level of imports constant. Imports under CAFTA-DR are not affected by the liberalization of the EU. All quotas are, as in the baseline scenario, completely filled.

Table 4-17: Results of the EU Liberalization Scenario for US Preferential Imports in thousand MT WSE [a]

2015/16	TRQs (incl. NAFTA)		CAFTA-DR
ARG	83.4	(-1%)	
AUS	161.1	(-1%)	
BEL	21.4	(-1%)	
BOL	15.7	(-1%)	
BRA	280.9	(-1%)	
CAN	37.9	(-1%)	
COL	46.5	(-1%)	
CON		(-100%)	
COR	29.1	(-1%)	11.9
COT		(-100%)	
DOM	273.0	(-1%)	10.9
ECU	21.4	(-1%)	
ELS	50.4	(-1%)	29.7
FIJ	14.0	(-1%)	
GUA	93.0	(-1%)	40.2
GUY	23.2	(-1%)	
HON	19.4	(-1%)	8.7
IND			
JAM	6.7	(1017%)	
MAD			
MAL	6.7	(n.a.)	
MEX			
MOZ	6.7	(n.a.)	
NIC	40.7	(-1%)	23.9
PAN	22.2		
PAR			
PER	79.4	(-1%)	
PHI	105.4		
PNG	6.7		
REA	15.0	(-1%)	
SAF	44.5	(-1%)	
STK	6.7		
SWA	31.0	(-1%)	
THA	27.0	(-1%)	
URU	6.7		
ZIM	23.2	(-1%)	
Total	1,599.0		124.3

Source: Own simulations; [a] Numbers in brackets are changes compared to the baseline scenario.

4.2.2.4 Scenario 4: Full Liberalization

Table 4-15 shows results of the model for global production, consumption and prices of sugar after full liberalization of all policies. The total quantity of global sugar production is not affected deeply. Shifts of production among countries are, however, immense. Highly protected industrialized countries reduce their production, whereas currently competitive exporters, above all Brazil, increase their production by high percentages. The world market price increases by 42% to € 295 per ton. This is, as expected, the highest value of all scenarios.

The production decrease in the EU is with 41% lower than in the EU liberalization scenario discussed in the previous section, but higher than in the Doha scenario, since the world market price increases stronger if other countries liberalize, too.

For the USA the decrease in supply is with 34% also stronger than in the DOHA scenario and again beet farmers are more affected than cane farmers. The former reduce their production by 54%, the latter by merely 11%. The USA imports under the liberalization scenario some 4.2 million tons of sugar, all of which enters, of course, duty free, which means there is no privileged market access for former quota holders anymore. The bulk of these imports enter from Brazil and Colombia with 1.3 and 1.2 million tons respectively. The remainder is delivered by El Salvador, Nicaragua, Costa Rica, Honduras, Guatemala, Dominican Republic, Belize, Panama and St. Kitts and Nevis in decreasing order. For all these countries but Guatemala, the USA becomes the only export market for sugar.

Most of the full liberalization scenario results are comparable to the WTO scenario with changes being more pronounced. There are a number of variables, though, which change in an opposite direction under full liberalization than they do under the WTO scenario. This is first of all the production in Cuba, where the state control of the sector is given up which was simulated by a subsidy equivalent between the production cost estimates from literature and the fob-based world market price. Only production is in this case affected differently than under the Doha scenario. Second, there are countries whose trade polices were not affected by the WTO agreement. Russia is not a WTO member. Therefore, its tariffs were not cut under the Doha scenario. The risen world market price translated into a higher domestic price and led to increased production and decreased consumption. The signs of the full liberalization scenario point in the opposite direction. The Russian wholesale price decreases after abolishing the tariff and hence supply decreases and demand increases. Indian trade policies were not affected by the Doha scenario since its bindings contained enough space to conserve its applied tariffs after reduction of the bindings. Also the increased world market price did not affect India since its tariff had been prohibitive in the baseline scenario. Under full liberalization, this changes. The domestic price is now the cif-based world market price. Consumption increases, production goes down.

Table 4-18: Results of the Full Liberalization Scenario in Million MT WSE and €/ton [a]

2015/16	Supply		Demand		Price	
World	151.3	(0%)	151.3	(0%)	295	(42%)
EU-27	9.6	(-41%)	19.9	(2%)	339	(-20%)
USA	4.6	(-34%)	8.9	(1%)	337	(-19%)
BRA	41.1	(31%)	11.0	(-3%)	277	(42%)
AUS	7.2	(22%)	1.2	(-4%)	289	(36%)
THA	7.2	(11%)	2.4	(-2%)	292	(19%)
GUA	2.2	(13%)	0.7	(-3%)	279	(42%)
CUB	1.6	(-9%)	0.7	(-3%)	282	(42%)
COL	3.3	(14%)	1.7	(-4%)	278	(44%)
SAF	2.8	(13%)	1.7	(6%)	286	(-45%)
RUS	2.4	(-2%)	6.1	(0%)	349	(-3%)
CHN	10.2	(3%)	11.8	(-1%)	347	(9%)
IND	20.7	(-6%)	22.4	(2%)	354	(-17%)
JAP	0.0	(-100%)	2.4	(9%)	342	(-67%)
Other	38.2	(-3%)	60.5	(0%)	-	-

Source: Own simulations; [a] Numbers in brackets are changes compared to the baseline scenario.

In table 4-16 the results of the full liberalization scenario for the sugar sector of the EU-27 are displayed. Overall production decreases by 41% to 9.6 million tons at an internal market price of € 339 per ton. As in the Doha scenario this is still above the reference price. Although all member states' production is affected by the liberalization, only three in countries, Portugal, Greece and Italy sugar production is brought to an end. Spain, which was predicted to cease production as well under the unilateral liberalization scenario discussed in the pervious section, reduces is supply by almost two thirds, but stays in the market. Other countries reduce their production in a range between 24% and 55%. Interestingly, there is even one country in the EU, Sweden, which is predicted to expand its sugar production slightly after abolishment of the quota.[94]

Under a MFN tariff of zero no preferential margins exist anymore. All imports of the EU-27, which are predicted to be 10.8 million tons, are simulated to come from Brazil and, though the share is tiny, from Eastern Europe. Again, producers in some former preferential exporters are worse off due to liberalization of the EU and other previously preferential markets. Given the higher world market price, however, this is less pronounced. The production decreases on average by 1%. Most affected countries are again Barbados and St. Kitts and

[94] This seems implausible at first glance, and essentially it is a result of the course of the supply curve, which is calibrated to the same low shadow price as those of, for instance, France or Germany. But there might also be an agronomic explanation: The conditions for summer crops such as sugar beet are especially advantageous in southern Sweden where these crops benefit from long periods of sunshine in the northern summer and do not suffer from the adverse conditions in winter as do cereals or rapeseed which in most cases are sown in fall.

Nevis, which reduce their production by 10% and 8% respectively (13% and 11% in the unilateral EU liberalization scenario).

As in the unilateral EU-27 liberalization scenario, the EU exports to Switzerland on an MFN base. Under full liberalization, however, the Swiss sugar production is projected to come to an end and hence the entire market is supplied from the neighbouring EU countries.

Table 4-19: EU Results of the Full Liberalization Scenario in Million MT WSE [a]

Production in Member States in 2015/16				**2015/16**	
AT	0.2477	(-36%)	LT	0.0483	(-53%)
BE	0.4801	(-41%)	LV	0	
CZ	0.3445	(-24%)	NL	0.5130	(-41%)
DK	0.1502	(-64%)	PL	1.1316	(-32%)
ES	0.1952	(-74%)	PT	0	(-100%)
FI	0.0448	(-59%)	SI	0	
FR	2.5315	(-37%)	SK	0.0824	(-55%)
GE	2.2852	(-37%)	SW	0.3357	(3%)
GR	0	(-100%)	UK	0.9475	(-17%)
HU	0.2752	(-31%)	BUL	0.0019	(-34%)
IE	0		ROM	0.0262	(-40%)
IT	0	(-100%)	Total	9.6410	(-41%)
Imports				10.7795	(232%)
Subsidized Exports				0.0	

Source: Own simulations; a Numbers in brackets are changes compared to the baseline scenario.

4.2.2.5 Comparison of Scenario Results for Selected LDCs

A particular strength of a model capturing bilateral trade flows explicitly is the ability to analyze the results of policy changes within the complex system of trade preferences and duty-free or duty reduced TRQs. Four countries which are especially deeply involved in this system are Ethiopia, Malawi, Mozambique and Zambia. All four countries are LDCs and have thus market access to the EU which will be duty and quota free as of 2009/10. They also benefit from the GSP of Norway[95], which allows duty free imports from LDCs as well. In addition, some of the countries have market access to the EU under the EU-ACP sugar protocol, to the US under the system of raw sugar TRQs, to Kenya under its TRQ for Common Market for Eastern and Southern Africa (COMESA) member states and to South Africa/ SACU under the quota for SADC member states. Furthermore, some of the countries are competitive on the world market for sugar and, of course, all countries have a domestic

[95] Note, that the exports of LDCs to Norway in the base are an artifact of the model, as has been explained in section 4.1.2.2.5

sugar market which they can choose to supply fully or in part themselves or by imports. To illustrate this, the results for exports, imports and domestic markets of these four countries under all four scenarios are examined in detail in this section.

Table 4-17 shows the result of the different scenarios including the base period for Ethiopia. In the base period the country exports to the EU-27 to fill its EBA quota and to Norway where no quantitative restriction exists. About half of the domestic market is supplied by Ethiopian sugar the other half coming from Brazil. In the baseline scenario, after unrestricted market access to the EU-27 under EBA is phased in, Ethiopia exports its entire production to the EU and supplies its domestic market by imports from Brazil. The exports to Norway are abolished, which is done by all other countries reviewed in this section, too. Norway fills its market by MFN imports from Colombia and the Caribbean instead. Tariff cuts under a possible Doha agreement decrease the price Ethiopian sugar can fetch in the EU-27, which remains, however, still the country's sole outlet. Thus, production and exports go down. A unilateral liberalization of its sugar policy by the EU-27 erodes the preferential margin Ethiopia enjoyed under EBA. The preferential market access to Norway becomes interesting again for the country under such circumstances. Also the domestic market is projected to be supplied entirely by home grown sugar. Despite the loss of preferential market access to the EU-27, the producers are better of under this scenario as compared to the Doha scenario, as the incentive price and hence production increase due to a stronger increase of the world market price. Under full liberalization the world market price increases even stronger, but no preferential access to any market exists anymore. Ethiopia supplies its domestic market where consumption slightly decreases and its neighbour Uganda.

Table 4-20: Comparison of Different Scenario Results for Ethiopia in thousand tons WSE

	Base	**Baseline**	**Doha**	**EU Liberalization**	**Full Liberalization**
Exports to:					
EU-27 (EBA)	14	354	337		
NOR (GSP)	138			37	
UGA (MFN)					49
Domestic	132			302	300
Imports from:					
BRA	131	305	303		
Total Supply	284	354	337	339	349
Total Demand	264	305	303	302	300
Producer Incentive Price	€ 243	€ 340	€ 295	€ 299	€325

Source: Own simulations.

In table 4-18 the model results of the different scenarios for Malawi are shown. In the base period the country fills preferential quotas to the EU under the sugar protocol and EBA, to Kenya under COMESA[96], and to the USA under the raw sugar TRQ. It also exports on a preferential (COMESA) basis to Eastern African countries and to Norway (GSP). Despite preferential treatment for all its exports, the producer incentive price for Malawi is with € 169 amazingly low, which results from its landlockeness. In the baseline scenario almost all of Malawi's exports go to the EU. Only the exports to Kenya are maintained which due to its proximity and its high MFN protection is an even more profitable export market for Malawi. Under the Doha scenario the producer incentive price decreases considerably, which has an affect on the level of production. The directions of trade remain, however, unchanged compared to the baseline scenario. Under the EU liberalization scenario Malawi turns back to its former preferential markets which are Norway and the US where Malawi's TRQ due to several years of underfillment is cut to a minimum boatload. As it has been the case for Ethiopia, Malawian producers benefit from the EU liberalization more than from a multilateral liberalization under the WTO, due to a higher world market price. Under full liberalization, Malawi turns to supplying the East African market by exporting its surplus to Tanzania. The producer incentive price is somewhat lower than under the baseline, where Malawi had unlimited preferential access to the EU-27, but the difference is not large. The effect on production at least is minor.

[96] Kenya has been granted a waiver for liberalization of its market access for sugar under COMESA. Instead a duty free TRQ for COMESA members had to be opened. Country specific TRQs are not published and according to USDA (2006, *GAIN Report KE6004*) trade that actually occurs is hard to capture. Therefore, the TRQ is for the model distributed to all COMESA members which are net exporters of sugar.

Table 4-21: Comparison of Different Scenario Results for Malawi in thousand tons WSE

	Base	**Baseline**	**Doha**	**EU Liberalization**	**Full Liberalization**
Exports to:					
EU-27 (ACP)	21	23	36		
EU-27 (EBA)	13	84	52		
NOR (GSP)	3			45	
KEN (COMESA)	6	6	6	6	
SUD (COMESA)	5				
TAN (MFN)					108
UGA (COMESA)	5			38	
USA (TRQ)	16			7	
Domestic	138	155	157	157	155
Imports from:	-	-	-	-	-
Total Supply	207	268	251	253	264
Total Demand	138	155	157	157	155
Producer Incentive Price	€ 169	€ 266	€ 220	€ 224	€ 253

Source: Own simulations.

Table 4-19 compares the scenario results for Mozambique. In the base period, Mozambique exports under various preferential schemes to the EU-27, the US and Norway and supplies its domestic market. In the baseline scenario, where preferential access under EBA becomes unrestricted, the entire production is shipped to the EU-27, and the domestic market is supplied by imports from Swaziland. Under the WTO scenario, the world market price increases, and the tariff, which is not reduced a lot due to water in the binding, provides a high degree of protection for the domestic market. In contrast, the protection of the EU market is reduced compared to the base. Therefore, sugar producers in Mozambique supply their own market and the EU market under their ACP-protocol quota and under EBA. With a prohibitive tariff in place, the domestic price is determined by the fob-based preferential export price the producers can fetch. Under the assumption of unilateral liberalization of EU policies, other options for preferential market access, Norway and the USA are used again. Like in Ethiopia and Malawi, producers in Mozambique are better off with EU liberalization than with multilateral liberalization under the WTO. Under full liberalization, Mozambique supplies its domestic market and exports the remainder to Iran. Unlike the former two countries, for producers in Mozambique full liberalization is the worst of all options, with a price almost 20% lower than in the baseline.

Table 4-22: Comparison of Different Scenario Results for Mozambique in thousand tons WSE

	Base	Baseline	Doha	EU Liberalization	Full Liberalization
Exports to:					
EU-27 (ACP)	12	13	21		
EU-27 (EBA)	28	261	86		
NOR (GSP)	24			101	
USA (TRQ)	21			7	
IRN (MFN)					101
Domestic	135		155	155	156
Imports from:					
SWA		154			
Total Supply	220	274	261	263	257
Total Demand	135	154	155	155	156
Producer Incentive Price	€ 239	€ 336	€ 290	€ 294	€ 274

Source: Own simulations.

The scenario results for Zambia are shown in table 4-20. In the base period Zambia uses a wide range of preferential market access options. These are ACP and EBA quotas on the EU-27 market, preferential access to Norway under its GSP, Congo (Democratic Republic (D.R.)) to Kenya, Sudan and Uganda under COMESA, and to the SACU under SADC. As in Malawi the producer price in the base is due to the landlocked position of the country very low. The assumption that both countries export via Mozambique and the fact that they export to the same markets lead to equal producer prices in both countries in all scenarios. In the baseline scenario, Zambia fills its TRQs in SACU and Kenya which is due to lower transportation costs and a higher price level more profitable than exporting to the EU and ships the rest of its surplus production to the EU under its ACP quota and EBA. Under the WTO scenario, the price in SACU sinks to world market level (see 4.2.2.2) and the TRQ becomes worthless for Zambia. Exports to other preferential markets are expanded as a consequence. Under liberalization of the EU, Zambian surplus production is simulated to exceed the possibilities for preferential market access and the country starts to export on a MFN base to Tanzania. Under full liberalization, Zambia exports its surplus to Tanzania and Congo (D. R.).

Table 4-23: Comparison of Different Scenario Results for Zambia in thousand tons WSE

	Base	**Baseline**	**Doha**	**EU Liberalization**	**Full Liberalization**
Exports to:					
EU-27 (ACP)	14	16	25		
EU-27 (EBA)	21	87	98		
NOR (GSP)	1			5	
CDR (COMESA)	40		30	30	17
KEN (COMESA)	7	7	7	7	
SAF (SADC)	23	70		70	
SUD (COMESA)	9				
TAN (MFN)				50	159
UGA (COMESA)	10				
Domestic	104	116	118	118	117
Imports from:					
Total Supply	229	297	279	281	292
Total Demand	104	116	118	118	117
Producer Incentive Price	€ 169	€ 266	€ 220	€ 224	€ 253

Source: Own simulations.

For producers in all countries surveyed in this section, the Baseline scenario brings the most beneficial results. Further liberalization has universally negative but different impacts on their sugar sectors. Producers in Mozambique are worse off under the assumption of full liberalization than under partial liberalization of a possible WTO agreement, while in the other three countries they are better off under full liberalization. For the sector in Mozambique, the loss of preferential market access weighs heavier than the gain through an increased world market price. Only two of the four countries made use of the so-called swap opportunity, i.e. exporting their production to the EU-27 under EBA and filling their domestic markets fully or partly by imports from third countries.

4.2.2.6 Sensitivity Analyses

In this section sensitivity analyses with respect to two parameters are carried out. The first of these is the BDI which is increased to 10,000 from the level of about 4000 which is assumed in the standard version of the model. The second are the supply elasticities of the isoelastic supply functions in the model which are first doubled and then halved. For all three variations of the model the baseline scenario and the full liberalization scenario are calculated again and the results of the simulations are compared to those obtained with the standard version of the model. Table 4-21 shows the results of a BDI of 10,000 in the baseline scenario. The high BDI increases ocean freight rates considerably. On the route from Brazil to the EU (Santos to Marseille), for instance, the rates increase from € 34 per ton WSE to about € 66. The influence on global production and consumption as well as world market prices is minor. In single countries, the results, however, changed compared to the standard version. In general, exporting countries face lower prices and importing countries face higher prices. Demand and supply react accordingly. There are, however, some interesting exemptions. In some exporting countries the fob price rises despite increased transportation costs to their export partners. The reason for this is that the price increase in those importing countries is so high that it outweighs the rise in transportation costs for the exporter. This happens in regions with a large deficit, which has to be imported over relatively large distances, such as Asia which imports from South America. Hence the fob price in Thailand increases. The opposite effect is an importing country facing lower prices resulting from increased global transportation costs. The fob price of its trade partner decreases stronger more than the bilateral transportation costs rise. The only country showing that effect in the sensitivity analysis carried out here is Paraguay.

First of all in Thailand and South Africa prices rise, although they are exporters. This is primarily due to the fact that the prices shown in the table are consumer prices and both countries despite being efficient producers protect their domestic markets, which makes them behave like those of importers. If one looks however at their producer prices (not in the table), one sees that they have risen as well. The explanation for this is, that two effects are counteracting here in their effects on the fob price of exporting countries. The first is the higher transportation cost to the destination which affects the fob price ceteris paribus negatively. The second is an increased cif price due to the higher transportation costs which has ceteris paribus an increasing effect also on the fob price. For countries like Brazil, the first effect dominates the second, because it is located in a surplus region and therefore has to ship its exports over longer distances, which increases the share of transportation costs in the revenue. For countries where the distances to the export markets are shorter, the second force, the increased cif price, dominates.

In the EU production and consumption are not affected a lot, but the price increases significantly. This comes via a reduction of preferential imports from LDCs under EBA which decrease by roughly 400 thousand tonnes. To fill the Gap, EU producers have to increase their production which is in many cases, however, limited by the quota. It takes therefore a relatively large price increase to provide sufficient incentive to producers in countries which underfill their quota to increase production. The price of Japan increases by the same amount as that of the EU, 6%. The effect on production, however, is huge. It increases by 20%. This is by reason of a supply function which is relatively elastic and the absence of quantitative limits of production.

The effect on total trade is interestingly minor. The total quantity which is exported and imported decreases by merely 3% compared to the standard version. The number of observed trade flows decreases by 2%.

Table 4-24: Sensitivity Analysis 1: Results of the Baseline Scenario [a]

2015/16	Supply			Demand			Price		
	Standard Version	BDI 10,000		Standard Version	BDI 10,000		Standard Version	BDI 10,000	
World	151.0	150.6	(-0%)	151.0	150.6	(-0%)	207	208	(0%)
EU-27	16.3	16.5	(1%)	19.5	19.4	(-1%)	426	450	(6%)
USA	7.1	7.1	(0%)	8.8	8.8	(0%)	414	414	(0%)
BRA	31.4	29.8	(-5%)	11.3	11.4	(1%)	196	183	(-6%)
AUS	5.9	5.7	(-3%)	1.2	1.2	(0%)	212	205	(-3%)
THA	6.5	6.6	(2%)	2.5	2.5	(0%)	246	251	(2%)
GUA	1.9	1.9	(0%)	0.7	0.7	(0%)	196	188	(-4%)
CUB	1.7	1.7	(0%)	0.7	0.7	(0%)	198	189	(-4%)
COL	2.9	2.9	(0%)	1.8	1.8	(0%)	194	189	(-2%)
SAF	2.5	2.5	(0%)	1.6	1.6	(0%)	517	527	(2%)
RUS	2.4	2.6	(8%)	6.1	6.0	(-2%)	359	391	(9%)
CHN	10.0	10.2	(2%)	11.9	11.9	(0%)	320	341	(7%)
IND	22.0	22.0	(0%)	22.0	22.0	(0%)	427	427	(0%)
JAP	1.0	1.2	(20%)	2.2	2.2	(0%)	1,023	1,086	(6%)
Other	39.4	39.9	(1%)	60.8	60.5	(0%)	-	-	-

Source: Own simulations; [a] Numbers in brackets are changes compared to the standard version.

In table 4-22 the results of an increased BDI are shown for the full liberalization scenario. The change in the world market price due to higher transportation costs is more pronounced here, which leads in all countries in the table to the domination of the transportation cost effect.[97] Production and prices increase and demand decreases in importing countries. For exporters the opposite can be observed. The effect is particularly visible for the EU, where production as a response on a 4% price increase expands by 19%. Unlike in the baseline scenario, all member states can contribute to the increase, since there is no quota in place anymore.

[97] Not for all countries in the model, though.

Table 4-25: Sensitivity Analysis 1: Results of the Full Liberalization Scenario [a]

2015/16	Supply			Demand			Price		
	Standard Version	BDI 10,000		Standard Version	BDI 10,000		Standard Version	BDI 10,000	
World	151.3	151.0	(-0%)	151.3	151.0	(-0%)	295	283	(-4%)
EU-27	9.6	11.5	(19%)	19.9	19.9	(-0%)	339	351	(4%)
USA	4.6	4.7	(2%)	8.9	8.9	(-0%)	337	339	(1%)
BRA	41.1	38.8	(-6%)	11.0	11.0	(1%)	277	258	(-7%)
AUS	7.2	6.9	(-3%)	1.2	1.2	(1%)	289	274	(-5%)
THA	7.2	7.2	(-0%)	2.4	2.4	(0%)	292	290	(-1%)
GUA	2.2	2.2	(-2%)	0.7	0.7	(1%)	279	263	(-6%)
CUB	1.6	1.5	(-2%)	0.7	0.7	(1%)	282	265	(-6%)
COL	3.3	3.3	(-2%)	1.7	1.7	(1%)	278	264	(-5%)
SAF	2.8	2.8	(-0%)	1.7	1.7	(0%)	286	284	(-1%)
RUS	2.4	2.5	(5%)	6.1	6.1	(-1%)	349	374	(7%)
CHN	10.2	10.3	(1%)	11.8	11.8	(-0%)	347	358	(3%)
IND	20.7	20.9	(1%)	22.4	22.3	(-0%)	354	365	(3%)
JAP	0.0	0.0	(0%)	2.4	2.4	(-0%)	342	353	(3%)
Other	38.2	38.3	(0%)	60.5	60.3	(0%)	-	-	-

Source: Own simulations; [a] Numbers in brackets are changes compared to the standard version.

Table 4-23 shows the results of the baseline scenario with a model version where all supply elasticities of isoelastic functions are doubled. The world market price is influenced negatively, i.e. the growth which could be observed in the baseline scenario relative to the base period is much less pronounced. This lower price is translated to all countries except for those with prohibitive tariffs in place. This is firstly the EU, where the price decrease is caused by increased imports under EBA, and second the USA. Demand does not respond much to the price decreases. Supply, due to increased elasticities, does not show great movements, either. The exemptions are Russia and Japan, where supply elasticities are high.[98]

[98] Production decrease in Cuba is considerably high as well. This is due to the simulation of the state control as a producer subsidy which decreases over time as a result of inflation. Thus Cuban production would have even decreased under this sensitivity analysis if the price would have stayed constant. Together with the effect of the price decrease, the production decrease is more pronounced than in most other countries.

Table 4-26: Sensitivity Analysis 2: Results of the Baseline Scenario [a]

2015/16	Supply			Demand			Price		
	Standard Version	ε * 2		Standard Version	ε * 2		Standard Version	ε * 2	
World	151.0	151.5	(0%)	151.0	151.5	(0%)	207	197	(-5%)
EU-27	16.3	16.1	(-1%)	19.5	19.6	(0%)	426	415	(-3%)
USA	7.1	7.1	(-0%)	8.8	8.8	(-0%)	414	415	(0%)
BRA	31.4	31.8	(1%)	11.3	11.4	(0%)	196	186	(-5%)
AUS	5.9	5.9	(1%)	1.2	1.2	(1%)	212	202	(-5%)
THA	6.5	6.6	(0%)	2.5	2.5	(0%)	246	234	(-5%)
GUA	1.9	2.0	(1%)	0.7	0.7	(0%)	196	187	(-5%)
CUB	1.7	1.7	(-4%)	0.7	0.7	(0%)	198	189	(-5%)
COL	2.9	3.0	(0%)	1.8	1.8	(1%)	194	184	(-5%)
SAF	2.5	2.5	(1%)	1.6	1.6	(1%)	517	491	(-5%)
RUS	2.4	2.3	(-3%)	6.1	6.1	(0%)	359	349	(-3%)
CHN	10.0	10.0	(1%)	11.9	12.0	(0%)	320	308	(-4%)
IND	22.0	22.1	(0%)	22.0	22.1	(0%)	427	413	(-3%)
JAP	1.0	0.9	(-8%)	2.2	2.2	(0%)	1,023	991	(-3%)
Other	39.4	39.6	(0%)	60.8	61.0	(0%)	-	-	-

Source: Own simulations; [a] Numbers in brackets are changes compared to the standard version.

The results of the sensitivity analysis for the full liberalization scenario are displayed in table 4-24. The world market price after liberalization is about 10% lower than projected with the standard version of the model. Since all countries face the world market price, this decrease translates to all domestic markets, with some local differences. Global production increases by about 1% with considerable reallocation of production taking place. Due to the lower price, EU-27 production is about half of what it would have been with the standard version. US production decreases less with just 42%. Beet production in the US, however, decreases by even 64% as a response to the lower price. Cane production on the other hand decreases by only 29% as a result of lower prices and a higher elasticity. Also other countries with large protection in the baseline face substantial decreases of production. The most important in absolute terms is India, where production decreases by 1.8 million tons.

The largest production increase in absolute as well as relative terms takes place in Brazil, where supply increases by 20% to almost 50 million tons. This alone more than outweighs the declining supply in the EU and the USA. Other exporting countries in the table increase their production by percentages between 6% and 14%, which is little in absolute terms, though.

Table 4-27: Sensitivity Analysis 2: Results of the Full Liberalization Scenario [a]

2015/16	Supply			Demand			Price		
	Standard Version	ε * 2		Standard Version	ε * 2		Standard Version	ε * 2	
World	151.3	152.6	(1%)	151.3	152.6	(1%)	295	264	(-10%)
EU-27	9.6	4.8	(-50%)	19.9	20.1	(1%)	339	308	(-9%)
USA	4.6	2.7	(-42%)	8.9	8.9	(0%)	337	306	(-9%)
BRA	41.1	49.4	(20%)	11.0	11.1	(1%)	277	247	(-11%)
AUS	7.2	8.1	(14%)	1.2	1.2	(1%)	289	258	(-11%)
THA	7.2	7.7	(6%)	2.4	2.4	(1%)	292	262	(-11%)
GUA	2.2	2.4	(9%)	0.7	0.7	(1%)	279	249	(-11%)
CUB	1.6	1.3	(-18%)	0.7	0.7	(1%)	282	252	(-11%)
COL	3.3	3.6	(9%)	1.7	1.7	(1%)	278	248	(-11%)
SAF	2.8	3.0	(8%)	1.7	1.7	(1%)	286	256	(-11%)
RUS	2.4	2.1	(-13%)	6.1	6.1	(1%)	349	319	(-9%)
CHN	10.2	10.2	(-0%)	11.8	11.9	(1%)	347	317	(-9%)
IND	20.7	18.9	(-9%)	22.4	22.6	(1%)	354	324	(-9%)
JAP	0.0	0.0	(0%)	2.4	2.4	(1%)	342	311	(-9%)
Other	38.2	38.3	(0%)	60.5	61.0	(1%)	-	-	-

Source: Own simulations; [a] Numbers in brackets are changes compared to the standard version.

Table 4-25 shows the results of the third sensitivity analysis, where all supply elasticities of isoelastic functions are halved, for the baseline scenario. As expected, the world market price increases as compared to the baseline simulated with the standard elasticity set, and so do all domestic prices. The EU having prohibitive tariffs in place is, as in the second sensitivity analysis, affected only by way its preferential imports. The imports entering the EU market under EBA are the only ones which are not quota limited, and thus basically the only ones whose overall quantity can vary. With production in LDCs decreasing relative to the standard version their exports to the EU decrease as well. The total quantity of preferential imports is declining by about 250 thousand tons, which leads to a 4% increase of the domestic price and a 1% increase of domestic production, which is for most member states limited by the quota. In the US, production, consumption and imports do not change at all due to a prohibitive tariff in place. The only country where production is affected significantly is Japan.

Table 4-28: Sensitivity Analysis 3: Results of the Baseline Scenario [a]

2015/16	Supply			Demand			Price		
	Standard Version	ε * ½		Standard Version	ε * ½		Standard Version	ε * ½	
World	151.0	150.3	(-0%)	151.0	150.3	(-0%)	207	222	(7%)
EU-27	16.3	16.5	(1%)	19.5	19.5	(-0%)	426	441	(4%)
USA	7.1	7.1	(0%)	8.8	8.8	(0%)	414	414	(0%)
BRA	31.4	30.8	(-2%)	11.3	11.2	(-1%)	196	210	(8%)
AUS	5.9	5.8	(-1%)	1.2	1.2	(-1%)	212	227	(7%)
THA	6.5	6.5	(-1%)	2.5	2.4	(-1%)	246	263	(7%)
GUA	1.9	1.9	(-1%)	0.7	0.7	(-1%)	196	210	(7%)
CUB	1.7	1.8	(2%)	0.7	0.7	(-1%)	198	212	(7%)
COL	2.9	2.9	(-1%)	1.8	1.8	(-1%)	194	208	(8%)
SAF	2.5	2.5	(-1%)	1.6	1.6	(-1%)	517	556	(8%)
RUS	2.4	2.5	(1%)	6.1	6.1	(-0%)	359	374	(4%)
CHN	10.0	9.9	(-1%)	11.9	11.9	(-1%)	320	337	(6%)
IND	22.0	21.9	(-0%)	22.0	21.9	(-0%)	427	449	(5%)
JAP	1.0	1.1	(12%)	2.2	2.2	(-0%)	1,023	1,073	(5%)
Other	39.4	39.3	(0%)	60.5	61.0	(-1%)	-	-	-

Source: Own simulations; [a] Numbers in brackets are changes compared to the standard version.

Under full liberalization, the reduced elasticities show a greater impact, as can be seen in table 4-26. World market and thus domestic prices increase by around 10% compared to the standard version. The impact on consumption is still minor with a decrease of 1% or less in the countries shown in table 4-26. Effects on supply are in contrast very large in many countries. In the EU and the USA, the higher world market price leads to a much smaller decrease in production after liberalization. The EU produces still some 14 million tons, which is only 2 million tons less than in the baseline scenario. The results for the USA are similar. Production decreases under liberalization to 6 million tons which is one million less than under prohibitive tariffs. As a consequence, production increases in exporting countries like Brazil, Australia and Thailand are less pronounced.[99]

[99] The exemption is again Cuba, for the same reasons as in the second sensitivity analysis.

Table 4-29: Sensitivity Analysis 3: Results of the Full Liberalization Scenario [a]

2015/16	Supply			Demand			Price		
	Standard Version	ε * ½		Standard Version	ε * ½		Standard Version	ε * ½	
World	151.3	150.0	(-1%)	151.3	150.1	(-1%)	295	324	(10%)
EU-27	9.6	14.1	(46%)	19.9	19.8	(-1%)	339	368	(9%)
USA	4.6	6.0	(30%)	8.9	8.8	(-0%)	337	366	(9%)
BRA	41.1	35.6	(-13%)	11.0	10.9	(-1%)	277	306	(10%)
AUS	7.2	6.5	(-10%)	1.2	1.2	(-1%)	289	322	(11%)
THA	7.2	6.9	(-5%)	2.4	2.4	(-1%)	292	325	(11%)
GUA	2.2	2.1	(-6%)	0.7	0.7	(-1%)	279	308	(10%)
CUB	1.6	1.7	(8%)	0.7	0.6	(-1%)	282	310	(10%)
COL	3.3	3.1	(-6%)	1.7	1.7	(-1%)	278	307	(10%)
SAF	2.8	2.6	(-6%)	1.7	1.6	(-1%)	286	315	(10%)
RUS	2.4	2.5	(4%)	6.1	6.1	(-1%)	349	378	(8%)
CHN	10.2	10.1	(-1%)	11.8	11.7	(-1%)	347	380	(9%)
IND	20.7	21.4	(3%)	22.4	22.2	(-1%)	354	383	(8%)
JAP	0.0	0.0	(0%)	2.4	2.4	(-1%)	342	375	(10%)
Other	38.2	37.6	(-2%)	60.5	60.0	(-1%)	-	-	-

Source: Own simulations; [a] Numbers in brackets are changes compared to the standard version.

Figure 4-3 summarizes the results of all sensitivity analyses carried out in this chapter by comparing the relative effect of Liberalization on production under the standard version and the three sensitivity analyses on the production of the world as a whole and in 13 single countries. Production on a global level is not affected a lot by the sensitivity analyses, as it has not been affected by the different scenarios either. The picture looks different for results in single countries although in virtually all cases the effects of liberalization go in the same direction as they do under the standard version of the model.

The effects of the first sensitivity analysis, the increase in ocean freight rates under the assumption of a BDI of 10,000 has only minor effects on the results of liberalization. In most cases, the results are dampened slightly as compared to the standard version. In two cases, however, Cuba and Russia, both of which reduce their production under liberalization, the sensitivity analysis increases this reduction as compared to the standard version.

The effects of the second and the third sensitivity analysis, the variation of the own price elasticities of supply, are much stronger. If elasticities are doubled, the effect of liberalization is strongly enhanced in all cases. In three countries the effect more than doubles. The effect is dampened if the elasticities are halved, as happened in the third sensitivity analysis. In Russia the sign of the effect even turns: Whereas under the standard version of the model, liberalization lead to a decrease of the internal price and thus to a reduction of supply, in the version with halved elasticities the price and thus supply in Russia even increase slightly.

The sensitivity analyses carried out in this chapter revealed that especially the influence of the supply elasticities on the results of the model is immense. Although the impact on global production, consumption and prices is modest, the results for single countries differ enormously in some cases between model versions with different supply elasticities. However, the direction of changes under liberalization does not change in most cases.

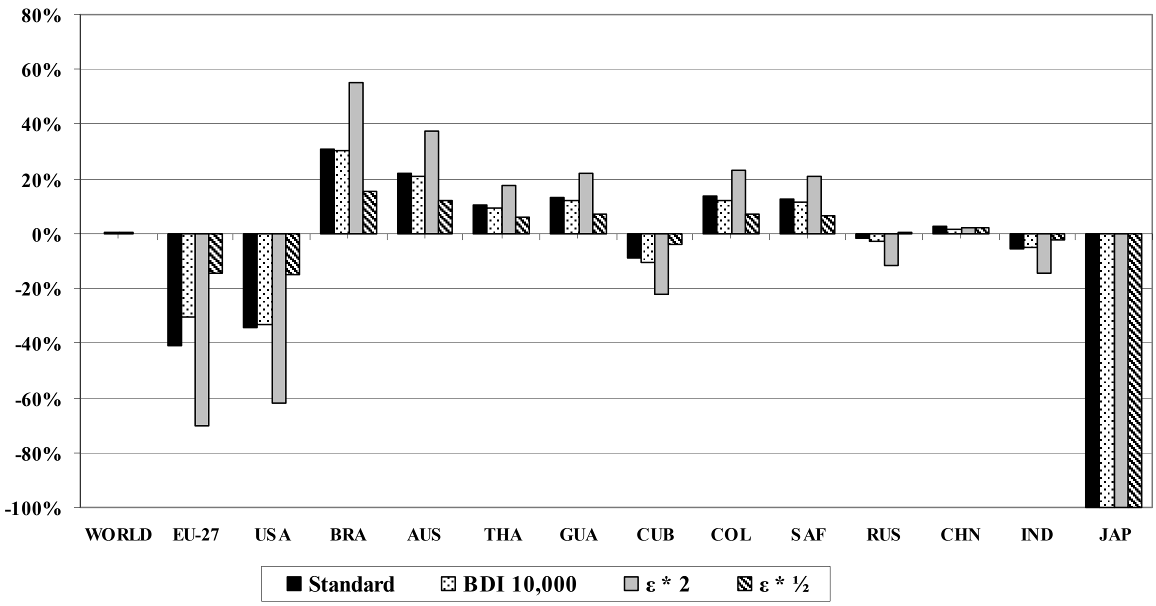

Figure 4-3: Sensitivity Analysis of the Effect of Full Liberalization on Sugar Production
Source: Own simulations.

5 Conclusions and Outlook

The simulations carried out in this study provide many interesting results. This applies to general variables such as production, consumption and prices, as well as to particular results such as bilateral trade flows.

Already the baseline scenario yields various interesting insights and answers to some of the research questions formulated in chapter one. One of this is the outcome of the reform process of the EU's CMO for sugar. Despite present doubts about the potential of the reform measures decided upon in 2006 to achieve the necessary quantity reductions, according to the model it is sufficient to reduce the price support for sugar to a level which is still considerably above the final envisaged reference price level. The reduction in price support is achieved by a reduction of the per unit export subsidy to merely bridge the gap between the fob world market price and the reference price. This reduction is simulated to be sufficient to completely discourage subsidized exports and to reduce the community production such that together with preferential imports, the EU market is balanced. The price prevailing on the EU market would still be considerably above the envisaged reference price level. This result clearly contrasts with the findings of Bureau et al. (2007). They simulate that even if the price would fall to the reference price level, the community market would still be oversupplied in 2015 and export subsidies would be necessary. Both results, the one obtained in this analysis and the one by Bureau et al. (2007), depend, of course, crucially upon the assumptions about supply behavior of EU sugar suppliers. The results also seem to contradict the fact that quota sales by sugar factories to the restructuring fund have lagged behind expectations so far. With the projected moderate level of imports under EBA and an increase in consumption, however, the necessary quota reduction still to achieve until the end of the implementation period of the CMO reform is less than one million tons, which is considerably below the 3.8 million tons currently envisaged.

The preference erosion brought about by the price decreases on the EU-27 market is rather low. Some countries end their preferential exports to the EU. In all these countries, however, the sugar sectors expand their production and the real prices producers can fetch increase. Other countries increase their preferential exports, which in total increase by 25% to 3.2 million tons, 1.3 of which are exported under EBA. Other studies which simulate a full implementation of EBA are not fully comparable due to different assumptions. Adenäuer et al. (2004) project import under EBA of a total of roughly 3 million tons. They assume, however, a development of the EU sugar market without the 2006 reform, and thus an internal EU price which is about 25% higher. Van Berkum et al. (2005) simulate imports under EBA of merely 250 thousand tons under the assumption implementation of the Fischler proposal for reforming the CMO. Under the assumption of an unreformed EU sugar market, the authors project imports of roughly 400 thousand tons, which is not much more. Their results, which are considerably lower than those obtained here and even more so than in other studies, clearly depend on the Armington Approach of heterogeneity with regard to origin.

Another interesting result is the termination of Mexican Exports to the USA despite of duty free access under NAFTA. None of the model-based studies reviewed in chapter 3 analyses the US sugar market and thus the question of Mexican exports. However, other, not model-based, sources expect these exports to rise considerably after 2008.[100]

The most interesting insight yielded by the WTO scenario is, that it is the level of the tariff which determines the future EU price level and thus production, rather than internal policies, i.e. the reference price. The EU starts to import 1.9 million tons under MFN conditions and production goes down accordingly. This is mitigated somewhat by the reduction of preferential imports by roughly a quarter to 2.5 million tons. The WTO scenario simulated by Bureau et al. (2007) deviates in its assumptions and its reference scenario too far from the analysis carried out in this study to be comparable. Merely the effect on the world market price could perhaps be compared, which increases with 6% by a much lower percentage than the 14% projected here. It is also an interesting fact to notice that the effects on the world market price by a possible WTO agreement are found to be lower than those of a unilateral complete liberalization of the EU, which increases the world market price by even 23%. None of the studies reviewed here does, however, simulate such a scenario. It would certainly be interesting to compare whether the other studies confirm or contradict the relative strengths of both world market price effects.

The full liberalization scenario projects a world market price increase of 42%. This seems rather high at first glance. The simulation of the same scenario by Elobeid and Beghin (2005), however, leads to an even higher increase with 47% and the authors state that their result moves “within the ballpark of previous estimates obtained with partial equilibrium models”. Mitchell (2004) surveys various model-based studies which have been published a few years earlier than the ones reviewed here, and their projections of world market price

[100] See section 4.1.2.3.2 and the cited literature.

effects of liberalization move around 40% as well. The homogeneous goods version of the model analysis by Van der Mensbrugghe et al. (2003) in contrast projects a world market increase of merely 21% in case of full liberalization, which is only half. This is even lower than the world market price increase of 34% which is projected here by the second sensitivity analysis using doubled own price elasticities of supply. All the world market price effects projected by other studies suffer, however, in comparability due to the fact that the reference scenario does not account for the implementation of the 2006 CMO reform by the EU.[101]

Under Full Liberalization the production decrease in the EU is projected to be 41% compared to the baseline scenario. The results of other studies are quite diverse. Elobeid and Beghin (2005) simulate a decrease of 60% which is quite in line with the results obtained here, since the authors reference situation is an unreformed EU market. The results of the two model versions of Van der Mensbrugghe et al. (2003), however, move far out if this range. The Armington version projects a decrease of 9%, the homogeneous goods version, however, projects a virtual stop of sugar production in the EU. Interestingly, the results of the two model versions depart, to a rather extreme degree, from the results obtained here in two different directions. One is much lower, the other one much higher. For the production of the remaining countries, most of the results of the full liberalization scenario of Elobeid and Beghin (2005) move in the same order of size as the ones obtained here. The exemptions are the USA where production decreases by only 5% (in contrast to 34% projected here), which is probably due to a lower assumed shadow price for producers, and Thailand where production decreases by 1% (while here it is projected to rise by 11%).[102] The results for production of Van der Mensbrugghe et al. (2003) deviate tremendously among the two model versions applied in the study and in most cases from the results obtained here. Most of the results of the Armington version suffer from the heterogeneity assumption. Decreases of production in formerly highly subsidizing countries are pronounced much less than one actually would expect, while competitive exporters increase their production only to a small degree. The homogeneous goods version of the model in contrast leads to rather extreme reactions. Production in the EU, the USA and Japan virtually disappears, while it triples in Australia and doubles in Thailand. Interestingly, production is terminated in SACU and tri-

[101] This applies, of course, to the comparability of all results of these studies with the one at hand.
[102] This could be due to the formulation of the Thai policies.

ples in the former Soviet Union. A figure for Brazil is not stated, the authors just mention the increase is “less”.[103]

The special ability of the model is the precise and realistic depiction of the development of bilateral trade flows in a changing political environment. It could be shown how erosion of preferences leads their beneficiaries to exporting to other destinations, some of which offer preferential market access as well, some of which do not. The detailed analysis of the complex network of preferential trading arrangements and the interdependencies of preferential trade flows with the development of the world market has shown that the effect of preference erosion on the affected sectors is moderate in most cases. In some cases the liberalization of sugar policies in preference granting countries has even a positive effect on the sugar sectors of the former beneficiaries of these preferences through an increase in the world market price.

It could also be shown that under open markets new, huge trade flows are generated, which due to prohibitive trade barriers did not exist before. The most prominent examples are the 9.9 and 13.6 million tons the EU is projected to import from Brazil under full multilateral and unilateral liberalization respectively. On the other hand, trade flows which prevailed are simulated to contract or to disappear. Brazil, for instance, is despite a large increase in total exports simulated to reduce its exports to the South and Central Asian market considerably under full multilateral liberalization and to practically withdraw from that region under unilateral liberalization by the EU. These results are not comparable to any of the model results reviewed in this study. The net-trade models do by nature not depict bilateral trade flows. The remainder of the models applies the Armington Approach, thus their projections cannot show such regime changes. Furthermore, their regional aggregation is in most cases rather rough, and even for the depicted regions results for bilateral trade flows are usually not published in detail.

The SPE model developed and applied in this study combines the strengths of two prevalent modeling approaches for the sugar market which are the assumption of homogeneity of goods and the ability to depict bilateral trade flows explicitly. The analyses carried out and the results obtained demonstrate the ability of the SPE approach to realistically simulate the effects of policy scenarios and to analyze them in high detail. It can, therefore, be consid-

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[103] The results suggest, that the supply is extremely elastic in this model version, which would in turn explain the comparably low world market price increase, and that the policies are misspecified, possibly by a protection coefficient applying to domestic production and exports, in some cases.

ered as a progress in comparison to the prevailing modeling methods for the sugar market. Yet, it suffers from one severe problem that the other two approaches are immune to. This is its inability to reproduce any arbitrary base data. This applies firstly to domestic prices where in many cases the gap to the world market price cannot be explained by the policies applied alone. This is a problem which net trade models face as well and it can be solved by introducing tariff equivalents, as is done in this study, or by introducing price transmission equations, as is done for instance by FAPRI. Second and more important, since it is a unique feature of SPE models, observed bilateral trade flows cannot be reproduced as is discussed in sections 4.1.2.2.5 and 4.1.2.2.6. For the reasons mentioned there, the unrealistic assumption of optimizing behavior and the incomplete coverage of all real world constraints in a model framework, this is inevitable if one applies a quasi-normative approach as a SPE. Especially in the light of the results of the validation of the model base data, it is hard to avoid the question: Do the results produced in this study have any relevance at all, if a given situation cannot be replicated satisfactorily? The author's answer would be in the affirmative: The model can replicate anything that a net-trade model can replicate, supply, demand, prices and net-trade with perfect accuracy. And the relevance of results of net-trade models is usually beyond doubts.[104] But in addition, it has more to offer. It can take into account, that the prices producers and consumers of sugar in a particular country face and that they compare with domestic prices in their decision making are in many cases not dependent on the world market price in New York City or London (and MFN-trade policies of their country), but on prices in countries with special bilateral trade relationships to their countries (and on these bilateral policies).

Some adjustments of the model with respect to the coverage of real world relationships could, however, contribute to enhancing the accuracy of reproduction of the base data. The most important step would be the distinction between raw and white sugar and the accommodation of a refining activity in the model.[105] This would allow accounting for the difference in transportation costs between both types of sugar and avoid the mistakes in the representation of situations as they have been described for the imports of Norway. Other steps could be a better empirical foundation of trade policies of the countries in the model and transportation cost parameters.

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[104] Of course, not beyond the doubts that apply to the concept of equilibrium modeling in general.

[105] This, however, requires the model to become dynamic, i.e. to allow the building up of refining capacities over time, to be meaningful for projections. Otherwise the interlinkages between the markets for both types of sugar would be heavily underestimated.

With all these facts correctly accounted for, the model would still not be able to reproduce observed base data. This phenomenon also occurs of course with all normative programming-based models and economists applying them have searched for solutions to that problem. For agricultural supply models it has been addressed by the development of positive mathematical programming (PMP) by Howitt (1995) and others. A detailed explanation of PMP would be beyond the scope of the study. In summary, it allows to convert a normative programming model into a positive one, i.e. give it the ability to reproduce base data. This is done by assigning a cost term to every observed activity and calibrating it such that the optimal outcome of the model accounting for this additional cost term is identical to the observed situation. Similarly, one could imagine attaching such a cost term to every observed trade flow in the base data of a SPE model and calibrating these costs such that the base data is reproduced. The question remains, however, how to treat the trade flows which are not observed, but which are regarded possible, i.e. which costs to attach to them? Any arbitrary (positive) amount (or function) of costs would be possible, since it does not influence the base situation. The same applies by the way also to supply models applying PMP. The modeler must take a decision about how to treat activities which are not pursued in the base, but may become profitable under policy scenarios.

The possible steps to enhance the model discussed above could help improving not only the accuracy of reproduction of base data, but also the quality of the projections. Additionally, there are some other possible adjustments, which although they will not have an impact on the accuracy of base data reproduction, will also contribute to improving simulation results. These include the separate modeling of agricultural production and processing, which would also facilitate the accommodation of further crop production activities in the model and the modeling of non-food (i.e. ethanol) use of sugar crops. Also assumptions about different inflation rates and changing exchange rates, which can heavily impact agricultural trade[106], could in future be made to enhance projections.

As discussed in section 3.1 already, all these model adjustments, which would certainly improve the quality of the projection results would, however, require a large amount of empirical work to be a realistic representation of real world constraints. Even without accommodating further features into the model applied here, better empirical foundation of assumptions, parameters and constraints could go a long way towards improving the simulation results, which is of course the case for any equilibrium model based study and usually

[106] See Grethe and Nolte (2005)

pointed out by the authors. For various reasons, the amount of empirical work which is actually carried out in order to enhance the quality of equilibrium models remains, however, low as compared to efforts of developing them methodologically.

Good empirical foundation is as the study has shown of particular importance for the approach used here, as it cannot be calibrated to reproduce any set of base data. The fact that the other model types which have been discussed in chapter 3, net-trade models and Armington-based gross trade models, do not exhibit this problem poses at first glance a significant advantage for these approaches. Perhaps it is this advantage which is the primary reason for their prevalence in agricultural economic equilibrium model analyses.

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Annex

Annex I: Base Data of the Model

	Supply	Demand	Producer Price	Consumer Price	Own Price Elasticity		MFN Tariffs	
	mill MT	mill MT	€/ ton	€/ ton	Supply	Demand	specific	ad valorem
AT	0.426		390		*			
BE	0.912		390		*			
CZ	0.524		465		*			
DK	0.488		440		*			
ES	1.002		540		*			
FI	0.147		540		*			
FR	4.187		390		*			
GE	3.921		390		*			
GR	0.309		540		*			
HU	0.467		465		*			
IE	0.209		540		*			
IT	1.506		540		*			
LT	0.123		515		*			
LV	0.067		515		*			
NL	0.865		390		*			
PL	1.891		415		*			
PT	0.072		540		*			
SI	0.043		515		*			
SK	0.224		515		*			
SW	0.399		390		*			
UK	1.287		390		*			
ALB	0.003	0.081	249.2	264.2	0.652	-0.075		10%
BOS		0.121		341.2		-0.075		10%
BUL	0.002	0.25	444	459	*	-0.075	106.5	50%
EUR		17.258		712		-0.088	537	
NOR		0.165		329.05		-0.157	172	
ROM	0.041	0.517	452	467	*	-0.075	92.7	60%
RUS	2.161	5.891	342.5	357.5	0.652	-0.075	114	
SER	0.345	0.306	354.9	369.9	0.652	-0.075		20%
SWI	0.202	0.382	540	723	0.028	-0.157	431	
TUR	1.865	1.84	521.8	536.8	0.050	-0.100		135%
ALG		1.082		250.2		-0.100		5%
BEN	0.004	0.033	629.5	279.9	0.333	-0.100		20%
BUR	0.035	0.063	339.7	354.7	0.333	-0.100		20%
CDR	0.054	0.083	258.593	273.593	0.333	-0.100		20%
CON	0.048	0.056	286.1	301.1	0.333	-0.100		30%
COT	0.117	0.204	263.7	278.7	0.333	-0.100		20%
EGY	1.421	2.295	249.2	264.2	0.333	-0.100		10%
ETH	0.284	0.264	242.55	257.55	0.333	-0.100		5%
GAB	0.019	0.019	286.1	301.1	0.333	-0.100		30%
GUI	0.023	0.104	263.7	278.7	0.333	-0.100		20%
KEN	0.486	0.67	444.5	459.5	0.333	-0.100		100%
MAD	0.021	0.125	269.7	284.7	0.333	-0.100		20%
MAL	0.206	0.138	168.55	183.55	0.333	-0.100		8%
MAU	0.505	0.039	625.5	306.3	0.333	-0.100		30%
MLI	0.03	0.089	339.7	354.7	0.333	-0.100		20%
MOR	0.434	1.067	481.75	496.75	0.333	-0.100	181	35%
MOZ	0.22	0.135	238.55	253.55	0.333	-0.100		68%
NIG	0.01	1.067	328.5	343.5	0.333	-0.100		50%
SAC		0.195		456		-0.075	30	164%
SAF	2.067	1.423	167.5	456	0.333	-0.100	30	163%
SEN	0.079	0.166	263.7	278.7	0.333	-0.100		20%
SRL	0.005	0.022	263.7	278.7	0.333	-0.100		20%
SUD	0.701	0.711	304.55	319.55	0.333	-0.100		40%
SWA	0.578	0.019	97.5	456	0.333	-0.100	30	352%
TAN	0.219	0.406	442.5	457.5	0.333	-0.100		100%
TOG		0.048		279.9		-0.100		20%

Sources: F.O. Licht, 2007; ISO, 2007; FAPRI, 2006; European Commission, 2007; Banse et al., 2007; Elobeid and Beghin, 2005; USDA (various years); Haley and Suarez, 2004; Stout and Abler, 2003; UNCTAD, 2007; WTO, 2007; Briner, 2006; Sandrey and Vink, 2007; Fiji Islands Revenue and Customs Authority (2007) ; own adjustments and simulations.

* Region does not have an isoelastic curve

Annex I continued: Base Data of the Model

	Supply	Demand	Producer Price	Consumer Price	Own Price Elasticity		MFN Tariffs	
	mill MT	mill MT	€/ ton	€/ ton	Supply	Demand	specific	ad valorem
UGA	0.166	0.193	443.76	458.76	0.333	-0.100		100%
ZAM	0.229	0.104	168.55	183.55	0.333	-0.100		25%
ZIM	0.399	0.279	168.55	183.55	0.333	-0.100		25%
BAR	0.032	0.016	659.5	317.7	0.326	-0.100		40%
BEL	0.099	0.011	243.7	258.7	0.326	-0.100		40%
CAN	0.093	1.281	235	245	0.633	-0.046	16	
COR	0.349	0.223	161.5	176.5	0.326	-0.100		45%
CUB	1.541	0.632	160.5	175.5	0.326	-0.100		10%
DOM	0.439	0.303	249.7	264.7	0.326	-0.100		15%
ELS	0.507	0.211	162.5	177.5	0.326	-0.100		40%
GUA	1.766	0.584	158.5	173.5	0.326	-0.100		20%
HAI		0.17		315.3		-0.100		40%
HON	0.324	0.239	160.5	175.5	0.326	-0.100		40%
JAM	0.133	0.111	442.5	315.3	0.326	-0.100		40%
MEX	5.137	5.034	442.5	457.5	0.326	-0.100	294	
NIC	0.409	0.183	161.5	176.5	0.326	-0.100		20%
PAN	0.148	0.107	441.5	456.5	0.326	-0.100		147%
STK	0.018	0.005	441.5	316.7	0.326	-0.100		40%
TRI	0.03	0.064	659.5	317.7	0.326	-0.100		40%
UB	3.736		472		*			
UC	3.138		430		0.720			
USA		8.516		518		-0.046	302	
ARG	1.829	1.493	159.5	174.5	0.326	-0.100		20%
BOL	0.291	0.238	167.256	182.256	0.326	-0.100		10%
BRA	25.435	9.75	158.5	173.5	0.722	-0.091		16%
CHL	0.352	0.636	228.86	345.86	0.652	-0.100	102	6%
COL	2.311	1.437	157.5	172.5	0.326	-0.100		20%
ECU	0.426	0.416	212.5	227.5	0.326	-0.100		20%
GUY	0.252	0.021	246.7	234.5	0.326	-0.100		40%
PAR	0.103	0.126	296.324	311.324	0.326	-0.100		30%
PER	0.674	0.852	214.5	229.5	0.326	-0.100		25%
SUR	0.004	0.02	301.7	316.7	0.326	-0.100		40%
URU	0.007	0.104	224.7	239.7	0.326	-0.100		5%
VEN	0.579	0.797	246.25	261.25	0.326	-0.100		15%
BAN	0.114	0.948	290.5	305.5	0.313	-0.100		25%
CHN	8.923	10.528	276.9	291.9	0.313	-0.100		20%
IND	17.574	18.212	377.7	395.7	0.313	-0.100	15	60%
INS	2.074	3.74	275.7	290.7	0.313	-0.100		20%
IRN	1.228	1.9	279.44	294.44	0.313	-0.100		19%
JAP	0.836	2.175	974	984	0.028	-0.078	744	
MLY	0.063	1.037	266	281	0.313	-0.100	33.5	
NEP	0.116	0.12	331.7	346.7	0.313	-0.100		10%
PAK	3.052	3.862	299.1	314.1	0.313	-0.100		30%
PNG	0.041	0.032	172.5	187.5	0.313	-0.100		70%
PHI	2.001	1.863	323.76	338.76	0.313	-0.100		65%
SOK		1.143		255.19		-0.157		3%
THA	4.935	2.055	179.5	221.425	0.313	-0.105		65%
AUS	4.875	1.098	180	190	0.620	-0.130		
FIJ	0.283	0.055	280	295	0.313	-0.100		27%
REU	2.166	2.018	167.5	182.5	0.652	-0.157		
RNE	0.12	4.14	227.5	242.5	0.333	-0.075		
RAF	0.465	0.808	266.1	281.1	0.333	-0.075		20%
RCA	0.065	0.031	159.5	174.5	0.326	-0.100		
RSA	0.152	2.244	232.5	247.5	0.313	-0.105		
REA	0.08	0.877	232.5	247.5	0.313	-0.105		
RSO	0.992	1.988	231.5	246.5	0.313	-0.105		

Sources: F.O. Licht, 2007; ISO, 2007; FAPRI, 2006; European Commission, 2007; Banse et al., 2007; Elobeid and Beghin, 2005; USDA (various years); Haley and Suarez, 2004; Stout and Abler, 2003; UNCTAD, 2007; WTO, 2007; Briner, 2006; Sandrey and Vink, 2007; Fiji Islands Revenue and Customs Authority (2007) ; own adjustments and simulations.

* Region does not have an isoelastic curve

Annex II: Trade flows in the Base Period after Calibration

Scheme	Origin	Destination					
		ALB	BOS	EUR	BUL	ROM	NOR
Domestic	ALB	0.0015					
Domestic	EUR			15.3936			
Domestic	BUL				0.0024		
Domestic	ROM					0.0407	
MFN	BRA	0.0790	0.1212		0.2479	0.4767	
CXL	CUB			0.0543			
CXL	GUA			0.0037			
CXL	BRA			0.0220			
CXL	AUS			0.0091			
Balkans	ALB			0.0013			
Balkans	REU			0.0053			
ACP	SER			0.2250			
ACP	CON			0.0102			
ACP	COT			0.0102			
GSP	ETH						0.1376
ACP	KEN			0.0100			
ACP	MAD			0.0108			
ACP/GSP	MAL			0.0208			0.0031
ACP	MAU			0.4910			
ACP/GSP	MOZ			0.0120			0.0239
ACP	SWA			0.1182			
ACP	TAN			0.0101			
ACP/GSP	ZAM			0.0144			0.0006
ACP	ZIM			0.0234			
ACP	BAR			0.0323			
ACP	BEL			0.0399			
ACP	JAM			0.1186			
ACP	STK			0.0156			
ACP	TRI			0.0297			
ACP	GUY			0.1550			
ACP	IND			0.0099			
ACP	FIJ			0.1677			
EBA	BEN			0.0038			
EBA	BUR			0.0080			
EBA	CDR			0.0117			
EBA	ETH			0.0138			
EBA	MOZ			0.0276			
EBA	SUD			0.0164			
EBA	BAN			0.0003			
EBA	NEP			0.0090			
SPS	CON			0.0017			
SPS	COT			0.0100			
SPS	KEN			0.0105			
SPS	MAD			0.0017			
SPS	MAU			0.0138			
SPS	SWA			0.0300			
SPS	ZIM			0.0250			
SPS	BEL			0.0020			
SPS	JAM			0.0064			
SPS	GUY			0.0080			
SPS	FIJ			0.0070			
SPS/EBA	MAL			0.0126			
SPS/EBA	TAN			0.0034			
SPS/EBA	ZAM			0.0211			

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex II Continued: Trade flows in the Base Period after Calibration

Scheme	Origin	Destination					
		RUS	SER	SWI	TUR	ALG	BEN
Domestic	RUS	2.1608					
Domestic	SER		0.1199				
Domestic	SWI			0.2023			
Domestic	TUR				1.8397		
MFN	BRA	3.7300	0.1863	0.1801		0.9318	0.0331
EXS	EUR					0.1500	
		BUR	CDR	CON	COT	EGY	ETH
Domestic	BUR	0.0273					
Domestic	CDR		0.0427				
Domestic	CON			0.0293			
UEMOA/Domestic	COT	0.0356			0.0380		
Domestic	EGY					1.4206	
Domestic	ETH						0.1323
COMESA	ZAM		0.0401				
MFN	BRA			0.0262	0.1661	0.8744	0.1314
		GAB	GUI	KEN	MAD	MAL	MAU
Domestic	GAB	0.0190					
Domestic	GUI		0.0226				
Domestic	KEN			0.4657			
Domestic	MAD				0.0023		
Domestic	MAL					0.1380	
MFN	BRA	0.0003	0.0817	0.1857	0.1225		0.0389
COMESA	MAL			0.0060			
COMESA	ZAM			0.0070			
COMESA	ZIM			0.0060			
		MLI	MOR	MOZ	NIG	SAC	SAF
UEMOA	COT	0.0168					
Domestic	MLI	0.0303					
Domestic	MOR		0.4339				
Domestic	MOZ			0.1351			
Domestic	NIG				0.0097		
Domestic	SAF						1.3776
MFN	SEN	0.0418					
SACU	SWA					0.1950	
MFN	HON		0.0542				
MFN	BRA		0.5448		1.0574		
MFN	RCA		0.0340				
SADC	ZAM						0.0229
SADC	ZIM						0.0220
		SEN	SRL	SUD	SWA	TAN	TOG
MFN	MAL			0.0045			
Domestic	SEN	0.0376					
Domestic	SRL		0.0050				
Domestic	SUD			0.6848			
Domestic	SWA				0.0194		
Domestic	TAN					0.2052	
MFN	ZAM			0.0086			
MFN	ZIM			0.0132			
MFN	BRA	0.1280	0.0174			0.2007	0.0483

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex II Continued: Trade flows in the Base Period after Calibration

Scheme	Origin	Destination					
		UGA	ZAM	ZIM	BAR	BEL	CAN
COMESA	MAL	0.0054					
Domestic	UGA	0.1661					
COMESA/Domestic	ZAM	0.0103	0.1038				
COMESA/Domestic	ZIM	0.0114		0.2785			
Domestic	BEL					0.0109	
Domestic	CAN						0.0610
MFN	CUB						0.1434
MFN	GUA						1.0762
CARICOM	GUY				0.0156		
		COR	CUB	DOM	ELS	GUA	HAI
Domestic/MFN	COR	0.2233		0.0845			
Domestic/MFN	CUB		0.6317	0.0031			0.1670
Domestic	DOM			0.2108			
Domestic	ELS				0.2109		
Domestic	GUA					0.5840	
MFN/Domestic	HON			0.0049			0.0032
		HON	JAM	MEX	NIC	PAN	STK
CARICOM	BEL						0.0033
MFN	COR		0.0151				
MFN	CUB		0.0911				
Domestic/MFN	HON	0.2391	0.0050				0.0013
Domestic	MEX			5.0339			
Domestic	NIC				0.1830		
Domestic	PAN					0.1074	

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex II Continued: Trade flows in the Base Period after Calibration

Scheme	Origin	Destination					
		TRI	USA	ARG	BOL	BRA	CHL
Domestic	UB		3.7355				
Domestic	UC		3.1376				
CARICOM	BEL	0.0254					
Domestic	ARG			1.4926			
Domestic	BOL				0.2385		
Domestic	BRA					9.7503	
Domestic	CHL						0.3520
MFN	COL						0.1786
CARICOM	GUY	0.0385					
TRQ	CON		0.0067				
TRQ	COT		0.0067				
TRQ	MAD		0.0067				
TRQ	MAL		0.0162				
TRQ	MOZ		0.0211				
TRQ	SAF		0.0373				
TRQ	SWA		0.0259				
TRQ	ZIM		0.0194				
TRQ	BEL		0.0179				
TRQ	CAN		0.0319				
TRQ	COR		0.0243				0.0015
TRQ	DOM		0.2284				
TRQ	ELS		0.0422				0.0015
TRQ	GUA		0.0778				0.0215
TRQ	HON		0.0162				
TRQ	JAM		0.0083				
TRQ/NAFTA	MEX		0.1032				
TRQ	NIC		0.0341				
TRQ	PAN		0.0408				
TRQ	STK		0.0026				
TRQ	ARG		0.0698				0.0346
TRQ	BOL		0.0130				0.0120
TRQ	BRA		0.2351				0.0177
TRQ	COL		0.0390				0.0162
TRQ	ECU		0.0179				
TRQ	GUY		0.0194				
TRQ	PAR		0.0067				
TRQ	PER		0.0665				
TRQ	URU		0.0067				
TRQ	IND		0.0104				
TRQ	PNG		0.0067				
TRQ	PHI		0.2023				
TRQ	THA		0.0227				
TRQ	AUS		0.1347				
TRQ	FIJ		0.0117				
TRQ	REA		0.0126				
		COL	ECU	GUY	PAR	PER	SUR
Preferential	BOL				0.0273		
Preferential	BRA			0.0213	0.0023		
Domestic/ANDEAN	COL	1.4371	0.0075			0.2448	
Domestic	ECU		0.4083				
CARICOM	GUY						0.0156
Domestic	PAR				0.0967		
Domestic	PER					0.6076	
Domestic	SUR						0.0044

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex II Continued: Trade flows in the Base Period after Calibration

Scheme	Origin	Destination					
		URU	VEN	BAN	CHN	IND	INS
MFN	SAF			0.0439		0.1807	
MFN	SWA			0.0976			
MFN	GUA		0.0025				
MFN	BRA	0.1041		0.6928		0.4779	0.9963
MFN	COL		0.2154				
Domestic	URU	0.0002					
Domestic	VEN		0.5789				
Domestic	BAN			0.1139			
Domestic	CHN				8.9233		
Domestic	IND					17.5537	
Domestic	INS						2.0735
MFN	THA				1.1525		
MFN	AUS				0.0017		0.6705
TRQ	CUB				0.4500		
		IRN	JAP	MLY	NEP	PAK	PNG
MFN	SAF	0.2455				0.1106	
MFN	SWA	0.0515				0.0409	
MFN	ELS		0.2293				
MFN	NIC		0.1687				
MFN	ARG	0.2323					
MFN	BRA				0.0125	0.6588	
Domestic	IRN	1.2281					
Domestic	JAP		0.8356				
Domestic	MLY			0.0634			
Domestic	NEP				0.1071		
Domestic	PAK					3.0522	
MFN/Domestic	PNG			0.0023			0.0321
MFN	AUS		0.8987	0.9712			
MFN	REU	0.1427					
TRQ	FIJ		0.0422				
		PHI	SOK	THA	AUS	FIJ	REU
MFN	ELS		0.0229				
MFN	NIC		0.0229				
MFN	COL		0.1721				
Domestic	PHI	1.7985					
ASEAN/MFN/Dom.	THA	0.0641	0.8319	2.0549			
MFN/Domestic	AUS		0.0937		1.0983		
Domestic	FIJ					0.0545	
Domestic	REU						2.0184
		RNE	RAF	RCA	RSA	REA	RSO
MFN	SAF				0.0714		
MFN	BRA	0.4702	0.3428		2.0206		
MFN	THA					0.8089	
MFN	AUS					0.0014	0.9956
Domestic	RNE	0.1204					
Domestic	RAF		0.4653				
Domestic	RCA			0.0309			
Domestic	RSA				0.1524		
Domestic	REA					0.0671	
Domestic	RSO						0.9921
Export Subsidies	EUR	3.5239					
Export Subsidies	TUR	0.0258					

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex III: Results of the Baseline Scenario

	Supply mill MT	Demand mill MT	Producer Price €/ ton	Consumer Price €/ ton
AT	0.3873		365	
BE	0.8198		362	
CZ	0.4549		365	
DK	0.4207		386	
ES	0.7533		416	
FI	0.1082		416	
FR	4.0325		365	
GE	3.6555		360	
GR	0.1464		416	
HU	0.4017		370	
IE				
IT	0.7251		416	
LT	0.103		404	
LV				
NL	0.8646		369	
PL	1.6719		359	
PT	0.0402		416	
SI				
SK	0.1849		416	
SW	0.3257		321	
UK	1.1386		345	
ALB	0.0033	0.0934	276	291
BOS		0.1409		368
BUL	0.0029	0.2803	419	434
EUR	16.2343	18.633		426
NOR		0.1876		396
ROM	0.0435	0.6103	419	434
RUS	2.42	6.0857	344	359
SER	0.3604	0.3604	321	336
SWI	0.2023	0.4532	525	662
TUR	2.0592	2.1726	582	597
ALG		1.2432		277
BEN	0.0035	0.0383	342	309
BUR	0.0404	0.0729	369	384
CDR	0.0664	0.0956	340	310
CON	0.0553	0.0642	317	332
COT	0.1353	0.2362	293	308
EGY	1.663	2.8181	276	291
ETH	0.3541	0.3052	341	284
GAB	0.0224	0.0223	341	334
GUI	0.0275	0.1207	343	308
KEN	0.5608	0.7757	493	508
MAD	0.0258	0.1444	337	314
MAL	0.2678	0.1546	266	281
MAU	0.468	0.045	360	339
MLI	0.0347	0.1031	369	384
MOR	0.4906	1.3347	478	493
MOZ	0.2744	0.1535	336	337
NIG	0.0112	1.2347	365	380
SAC		0.2258		517
SAF	2.4968	1.5619	191	517
SEN	0.0967	0.1916	344	308
SRL	0.0061	0.0259	343	308
SUD	0.812	0.822	342	357
SWA	0.692	0.0222	121	560
TAN	0.2526	0.4695	493	508
TOG		0.0559		309

Source: Own simulations.

Annex III continued: Results of the Baseline Scenario

	Supply mill MT	Demand mill MT	Producer Price €/ ton	Consumer Price €/ ton
UGA	0.1914	0.2236	490	505
ZAM	0.2969	0.1163	266	281
ZIM	0.4747	0.3196	205	220
BAR	0.0297	0.018	366	353
BEL	0.1155	0.0126	277	292
CAN	0.1037	1.421	257	267
COR	0.4057	0.2578	184	199
CUB	1.7309	0.6769	183	198
DOM	0.507	0.3509	278	293
ELS	0.5888	0.2436	185	200
GUA	1.943	0.7337	181	196
HAI		0.1968		350
HON	0.3777	0.2759	184	199
JAM	0.1359	0.1287	337	350
MEX	5.6973	5.6973	470	485
NIC	0.4749	0.2114	184	199
PAN	0.1511	0.1289	336	351
STK	0.0186	0.0053	336	351
TRI	0.0273	0.0739	365	353
UB	3.8379		391	
UC	3.2236		382	
USA		8.7858		414
ARG	2.2705	1.768	181	196
BOL	0.3335	0.2765	183	198
BRA	31.3698	11.3088	181	196
CHL	0.4192	0.742	253	350
COL	2.9407	1.7647	179	194
ECU	0.4906	0.4815	235	250
GUY	0.2927	0.0247	280	259
PAR	0.1176	0.1467	315	330
PER	0.8491	1.01	238	253
SUR	0.0051	0.0231	337	352
URU	0.0079	0.1208	248	263
VEN	0.6382	0.9556	274	289
BAN	0.133	1.097	335	338
CHN	9.9578	11.9288	305	320
IND	21.9972	21.9972	410	427
INS	2.3645	4.1764	305	320
IRN	1.3542	2.2456	309	324
JAP	1.0018	2.1962	1013	1023
MLY	0.0724	1.2662	283	298
NEP	0.1327	0.1387	359	374
PAK	3.8275	4.8065	332	347
PNG	0.0476	0.0371	195	210
PHI	2.3749	2.2695	317	332
SOK		1.2399		279
THA	6.5428	2.4607	201	246
AUS	5.862	1.2254	202	212
FIJ	0.3066	0.0643	255	270
REU	2.6264	2.3152	191	206
RNE	0.1388	4.8045	252	267
RAF	0.5374	0.9372	296	311
RCA	0.0755	0.0357	182	197
RSA	0.1754	2.5966	258	273
REA	0.0915	1.0159	256	271
RSO	1.1405	2.3004	256	271

Source: Own simulations.

Annex III continued: Trade flows in the Baseline Scenario

Scheme	Origin	Destination					
		ALB	BOS	EUR	BUL	ROM	NOR
Domestic	ALB	0.0020					
Domestic	EUR			16.2343			
Domestic	BUL				0.0029		
Domestic	ROM					0.0435	
EBA	BEN			0.0034			
EBA	CDR			0.0664			
EBA	ETH			0.3270	0.0136	0.0134	
EBA	GAB			0.0224			
EBA	GUI			0.0275			
EBA	MAD				0.0070	0.0068	
EBA	MAL			0.0460	0.0191	0.0190	
EBA	MOZ			0.2288	0.0162	0.0160	
EBA	SEN			0.0967			
EBA	SRL			0.0061			
EBA	SUD				0.0057	0.1756	
EBA	ZAM			0.0493	0.0191	0.0190	
EBA	BAN			0.1055	0.0138	0.0137	
MFN	BRA	0.0914	0.1409				
MFN	COL						0.1478
MFN	RCA						0.0398
CXL	CUB			0.0543			
CXL	GUA			0.0037			
CXL	BRA			0.0220	0.1828	0.3033	
CXL	AUS			0.0091			
Balkans	ALB			0.0013			
Balkans	REU			0.0053			
ACP	CON			0.0113			
ACP	COT			0.0113			
ACP	MAD			0.0120			
ACP	MAL			0.0231			
ACP	MAU			0.4680			
ACP	MOZ			0.0133			
ACP	SWA			0.1311			
ACP	ZAM			0.0160			
ACP	ZIM			0.0260			
ACP	BAR			0.0297			
ACP	BEL			0.0443			
ACP	JAM			0.1353			
ACP	STK			0.0172			
ACP	TRI			0.0273			
ACP	GUY			0.1719			
ACP	FIJ			0.1860			

Source: Own simulations.

Annex III continued: Trade flows in the Baseline Scenario

Scheme	Origin	Destination					
		RUS	SER	SWI	TUR	ALG	BEN
Domestic	RUS	2.4200					
Domestic	SER		0.3604				
Domestic	SWI			0.2023			
Domestic	TUR				2.0592		
MFN	BRA	3.6657		0.2509	0.1134	1.2432	0.0383
		BUR	CDR	CON	COT	EGY	ETH
Domestic	BUR	0.0404					
Domestic	CON			0.0372			
UEMOA/Domestic	COT	0.0325			0.0164		
Domestic	EGY					1.4718	
MFN	BRA		0.0956	0.0270	0.2198	1.3463	0.3052
		GAB	GUI	KEN	MAD	MAL	MAU
Domestic	KEN			0.5608			
Domestic	MAL					0.1546	
MFN	BRA	0.0223	0.1207	0.1960	0.1444		0.0450
COMESA	MAL			0.0060			
COMESA	ZAM			0.0070			
COMESA	ZIM			0.0060			
		MLI	MOR	MOZ	NIG	SAC	SAF
UEMOA	COT	0.0684					
Domestic	MLI	0.0347					
Domestic	MOR		0.4906				
Domestic	NIG				0.0112		
Domestic	SAF						1.4242
SACU	SWA			0.1535		0.2258	
MFN	BRA		0.8441		1.2235		
SADC	ZAM						0.0702
SADC	ZIM						0.0675
		SEN	SRL	SUD	SWA	TAN	TOG
COMESA	EGY			0.1912			
Domestic	SUD			0.6307			
Domestic	SWA				0.0222		
Domestic	TAN					0.2526	
MFN	BRA	0.1916	0.0259			0.2169	0.0559

Source: Own simulations.

Annex III continued: Trade flows in the Baseline Scenario

Scheme	Origin	Destination					
		UGA	ZAM	ZIM	BAR	BEL	CAN
Domestic	UGA	0.1914					
Domestic	ZAM		0.1163				
COMESA/Domestic	ZIM	0.0323		0.3196			
Domestic	BEL					0.0126	
Domestic	CAN						0.0654
MFN	CUB				0.0006		0.3054
MFN	GUA						1.0502
CARICOM	GUY				0.0175		
		COR	CUB	DOM	ELS	GUA	HAI
Domestic/MFN	COR	0.2578		0.0601			
Domestic/MFN	CUB		0.6769	0.0263			0.1968
Domestic	DOM			0.2208			
Domestic	ELS				0.2436		
Domestic	GUA					0.7337	
MFN/Domestic	HON			0.0437			
		HON	JAM	MEX	NIC	PAN	STK
CARICOM	BEL		0.0371				
MFN	COR		0.0450				
MFN	CUB		0.0167				0.0040
Domestic/MFN	HON	0.2759	0.0300				
Domestic	MEX			5.6973			
Domestic	NIC				0.2114		
Domestic	PAN					0.1289	
Domestic	STK						0.0013

Source: Own simulations.

Annex III continued: Trade flows in the Baseline Scenario

Scheme	Origin	Destination					
		TRI	USA	ARG	BOL	BRA	CHL
Domestic	UB		3.8379				
Domestic	UC		3.2236				
Domestic	ARG			1.7680			
Domestic	BOL				0.2765		
Domestic	BRA					11.3088	
Domestic	CHL						0.4192
MFN	COL						0.2178
CARICOM	GUY	0.0739					
TRQ	CON		0.0067				
TRQ	COT		0.0067				
TRQ	SAF		0.0448				
TRQ	SWA		0.0313				
TRQ	ZIM		0.0234				
TRQ	BEL		0.0216				
TRQ	CAN		0.0383				
TRQ	COR		0.0294				0.0015
TRQ	DOM		0.2753				
TRQ	ELS		0.0509				0.0015
TRQ	GUA		0.0937				0.0215
TRQ	HON		0.0195				
TRQ	JAM		0.0006				
TRQ	NIC		0.0411				
TRQ	PAN		0.0222				
TRQ	ARG		0.0841				0.0346
TRQ	BOL		0.0158				0.0120
TRQ	BRA		0.2836				0.0177
TRQ	COL		0.0470				0.0162
TRQ	ECU		0.0216				
TRQ	GUY		0.0234				
TRQ	PER		0.0802				
TRQ	URU		0.0067				
TRQ	PNG		0.0067				
TRQ	PHI		0.1054				
TRQ	THA		0.0273				
TRQ	AUS		0.1625				
TRQ	FIJ		0.0141				
TRQ	REA		0.0151				
CAFTA	COR		0.0119				
CAFTA	DOM		0.0109				
CAFTA	ELS		0.0297				
CAFTA	GUA		0.0402				
CAFTA	HON		0.0087				
CAFTA	NIC		0.0239				
		COL	ECU	GUY	PAR	PER	SUR
Preferential	BOL				0.0292		
Preferential	BRA			0.0247			0.0120
Domestic/ANDEAN	COL	1.7647	0.0125			0.2411	
Domestic	ECU		0.4690				
CARICOM	GUY						0.0060
Domestic	PAR				0.1176		
Domestic	PER					0.7689	
Domestic	SUR						0.0051

Source: Own simulations.

Annex III continued: Trade flows in the Baseline Scenario

Scheme	Origin	Destination					
		URU	VEN	BAN	CHN	IND	INS
MFN	SAF			0.7652			
MFN	SWA			0.0695			
MFN	ARG	0.1195					
MFN	BRA			0.1192			
MFN	COL		0.3174				
Domestic	URU	0.0012					
Domestic	VEN		0.6382				
Domestic	CHN				9.9578		
Domestic	IND					21.9972	
Domestic	INS						2.3645
MFN	THA				1.5209		
MFN	AUS			0.1431			1.8120
TRQ	CUB				0.4500		
		IRN	JAP	MLY	NEP	PAK	PNG
MFN	SAF	0.2626					
MFN	SWA	0.0586					
MFN	ELS		0.2631				
MFN	NIC		0.1986				
MFN	ARG	0.2643					
MFN	BRA				0.0060	0.9789	
Domestic	IRN	1.3542					
Domestic	JAP		1.0018				
Domestic	MLY			0.0724			
Domestic	NEP				0.1327		
Domestic	PAK					3.8275	
MFN/Domestic	PNG		0.0038				0.0371
MFN	THA		0.5306				
MFN	AUS		0.1563	1.1938			
MFN	REU	0.3059					
TRQ	FIJ		0.0422				
		PHI	SOK	THA	AUS	FIJ	REU
MFN	COL		0.1761				
Domestic	PHI	2.2695					
MFN/Domestic	THA		1.0638	2.4607			
Domestic	AUS				1.2254		
Domestic	FIJ					0.0643	
Domestic	REU						2.3152
		RNE	RAF	RCA	RSA	REA	RSO
MFN	BRA	4.6658	0.3998		2.4212		
MFN	THA					0.9395	
MFN	AUS						1.1599
Domestic	RNE	0.1388					
Domestic	RAF		0.5374				
Domestic	RCA			0.0357			
Domestic	RSA				0.1754		
Domestic	REA					0.0764	
Domestic	RSO						1.1405

Source: Own simulations.

Annex IV: Results of the Doha Scenario

	mill MT	mill MT	€/ ton	€/ ton
AT	0.3873		365	
BE	0.8198		362	
CZ	0.4549		365	
DK	0.3559		370	
ES	0.4844		370	
FI	0.0792		370	
FR	4.0325		365	
GE	3.6555		360	
GR	0.0551		370	
HU	0.4017		370	
IE			701	
IT	0.3518		370	
LT	0.0804		370	
LV			701	
NL	0.8646		369	
PL	1.6719		359	
PT	0.0205		370	
SI			701	
SK	0.1356		370	
SW	0.3257		321	
UK	1.1386		345	
ALB	0.0035	0.093	292	307
BOS		0.1402		393
BUL	0.0024	0.2826	373	388
EUR	15.3154	18.8204		380
NOR		0.1936		323
ROM	0.0352	0.6154	373	388
RUS	2.5233	6.0577	366	381
SER	0.3604	0.3604	321	336
SWI	0.096	0.4734	439	501
TUR	1.6369	2.2185	469	484
ALG		1.2329		300
BEN	0.0034	0.038	321	336
BUR	0.0414	0.0724	396	411
CDR	0.0646	0.095	313	328
CON	0.0554	0.0642	321	336
COT	0.1394	0.2342	320	335
EGY	1.7118	2.7949	301	316
ETH	0.3374	0.3027	295	308
GAB	0.0222	0.0222	332	347
GUI	0.0269	0.1197	320	335
KEN	0.5345	0.7866	427	442
MAD	0.0255	0.1433	325	340
MAL	0.2514	0.1574	220	235
MAU	0.4473	0.0451	314	329
MLI	0.0355	0.1024	396	411
MOR	0.5008	1.3236	509	524
MOZ	0.2613	0.155	290	305
NIG	0.0115	1.2241	399	414
SAC		0.232		359
SAF	2.5883	1.6955	212	227
SEN	0.0944	0.19	320	335
SRL	0.0059	0.0257	320	335
SUD	0.8021	0.8249	329	344
SWA	0.7313	0.0252	142	157
TAN	0.2464	0.4729	457	472
TOG		0.0554		336

Source: Own simulations.

Annex IV continued: Results of the Doha Scenario

	Supply mill MT	Demand mill MT	Producer Price €/ ton	Consumer Price €/ ton
UGA	0.1838	0.2263	434	449
ZAM	0.2787	0.1184	220	235
ZIM	0.4638	0.3217	191	206
BAR	0.0284	0.0181	320	335
BEL	0.1148	0.0126	272	287
CAN	0.1078	1.4172	273	283
COR	0.4229	0.2548	209	224
CUB	1.7694	0.6689	208	223
DOM	0.5031	0.3517	272	287
ELS	0.6118	0.241	208	223
GUA	2.0267	0.7249	206	221
HAI		0.1971		346
HON	0.3944	0.2725	210	225
JAM	0.1334	0.1294	318	333
MEX	5.3864	5.7929	396	411
NIC	0.4936	0.2091	207	222
PAN	0.141	0.1315	272	287
STK	0.0183	0.0053	320	335
TRI	0.0265	0.074	332	347
UB	2.2093		340	
UC	2.9669		340	
USA		8.8541		350
ARG	2.3563	1.7494	202	217
BOL	0.3375	0.2756	189	204
BRA	34.1766	11.1961	203	218
CHL	0.4906	0.7446	323	338
COL	3.0728	1.7428	204	219
ECU	0.507	0.4769	260	275
GUY	0.2907	0.0244	274	281
PAR	0.1162	0.1473	304	319
PER	0.8781	1.0003	263	278
SUR	0.005	0.0232	329	344
URU	0.0081	0.12	267	282
VEN	0.6506	0.9503	291	306
BAN	0.135	1.0885	350	365
CHN	10.2325	11.8302	332	347
IND	21.9972	21.9972	410	427
INS	2.4297	4.1419	332	347
IRN	1.3887	2.2285	335	350
JAP		2.3515	674	426
MLY	0.0742	1.2569	306	321
NEP	0.1355	0.1378	384	399
PAK	3.9313	4.7673	361	376
PNG	0.0493	0.0367	218	233
PHI	2.2587	2.2587	270	348
SOK		1.2241		303
THA	6.7694	2.4343	224	272
AUS	6.268	1.209	225	235
FIJ	0.3241	0.0632	305	320
REU	2.8182	2.2789	212	227
RNE	0.1428	4.7751	274	289
RAF	0.522	0.9431	271	286
RCA	0.0792	0.0352	210	225
RSA	0.1801	2.5748	280	295
REA	0.094	1.0072	279	294
RSO	1.1717	2.2807	279	294

Source: Own simulations.

Annex IV continued: Tariff Cuts of the Doha Scenario

	Ad Valorem Tariffs	Specific Duties	cif price in base	Ad valorem equivalent of specific duties	Total Ad valorem equivalent	Developing or industrialized county	UR bound tariffs		Doha bound tariffs		Post Doha applied tariffs	
							ad valorem	specific duty	ad valorem	specific duty	ad valorem	specific duty
ALB	10%		217		10%	D	10%		6.6%		6.6%	
BOS	10%		287		10%	D					10.0%	
EUR		537	218	246%	246%	I		419		125.7	0.0%	125.7
NOR		172	218	79%	79%	I		172		51.6	0.0%	51.6
RUS		114	218	52%	52%	D					0.0%	114
SER	20%		287		20%	D					20.0%	
SWI		431	275	157%	157%	I		429 +73		128.7	0.0%	201.7
TUR	135%		218		135%	D	135%		72.5%		72.5%	
ALG	5%		214		5%	D					5.0%	
BEN	20%		212		20%	D	60%		37.0%		20.0%	
BUR	20%		281		20%	D	100%		57.7%		20.0%	
CDR	20%		212		20%	D	100%		57.7%		20.0%	
CON	30%		212		30%	D	30%		19.8%		19.8%	
COT	20%		211		20%	D	15%		9.9%		9.9%	
EGY	10%		217		10%	D	20%		13.2%		10.0%	
ETH	5%		221		5%	D					5.0%	
GAB	30%		212		30%	D	60%		37.0%		30.0%	
GUI	20%		211		20%	D	40%		24.7%		20.0%	
KEN	100%		217		100%	D	100%		57.7%		57.7%	
MAD	20%		216		20%	D	30%		19.8%		19.8%	
MAL	8%		224.8		8%	D	125%		72.1%		7.5%	
MAU	30%		216		30%	D	122%		70.4%		30.0%	
MLI	20%		281		20%	D	60%		37.0%		20.0%	
MOR	35%	181	215	84%	119%	D	168%		90.2%		90.2%	
MOZ	68%		163		68%	D	100%		57.7%		57.7%	
NIG	50%		212		50%	D	150%		80.6%		50.0%	
SAC	164%	30	163	18%	183%	D	105%		60.6%		60.6%	
SAF	163%	30	163	18%	182%	D	105%		60.6%		60.6%	
SEN	20%		211		20%	D	30%		19.8%		19.8%	
SRL	20%		211		20%	D	40%		24.7%		20.0%	
SUD	40%		222		40%	D					40.0%	
SWA	352%	30	233	13%	365%	D	105%		60.6%		60.6%	
TAN	100%		216		100%	D	120%		69.2%		69.2%	
TOG	20%		212		20%	D	80%		49.4%		20.0%	
UGA	100%		287		100%	D	80%		49.4%		49.4%	
ZAM	25%		224.8		25%	D	125%		72.1%		25.0%	
ZIM	25%		224.8		25%	D	150%		80.6%		25.0%	
BAR	40%		209		40%	D	122%		70.4%		40.0%	
BEL	40%		205		40%	D	100%		57.7%		40.0%	
CAN		16	212	8%	8%	I		16		4.8	0.0%	4.8
COR	45%		207		45%	D	45%		27.8%		27.8%	
CUB	10%		207		10%	D	40%		24.7%		10.0%	
DOM	15%		208		15%	D	85%		49.0%		15.0%	
ELS	40%		203		40%	D	70%		43.2%		40.0%	
GUA	20%		204		20%	D	160%		85.9%		20.0%	
HAI	40%		207		40%	D	40%		24.7%		24.7%	
HON	40%		207		40%	D	40%		24.7%		24.7%	
JAM	40%		207		40%	D	100%		57.7%		40.0%	
MEX		294	208	141%	141%	D		294			0.0%	157.9
NIC	20%		203		20%	D	100%		57.7%		20.0%	
PAN	147%		204		147%	D	144%		77.3%		77.3%	
STK	40%		208		40%	D	130%		75.0%		40.0%	
TRI	40%		209		40%	D	100%		57.7%		40.0%	
USA		302	208	145%	145%	I		301		90.3	0.0%	90.3
ARG	20%		204		20%	D	35%		21.6%		20.0%	
BOL	10%		225		10%	D	40%		24.7%		10.0%	
BRA	16%		205		16%	D	35%		21.6%		16.0%	
CHL	6%	102	206	50%	56%	D	98%		56.5%		3.5%	58.9
COL	20%		205		20%	D	117%		67.5%		20.0%	
ECU	20%		202		20%	D	38%		23.1%		20.0%	
GUY	40%		209		40%	D	100%		57.7%		40.0%	
PAR	30%		224		30%	D	30%		19.8%		19.8%	
PER	25%		204		25%	D	49%		30.2%		25.0%	
SUR	40%		209		40%	D	20%		13.2%		13.2%	
URU	5%		204		5%	D	35%		21.6%		5.0%	
VEN	15%		205		15%	D	105%		60.6%		15.0%	
BAN	25%		224		25%	D	200%		107.4%		25.0%	
CHN	20%		222		20%	D	50%		30.9%		20.0%	
IND	60%	15	222	7%	67%	D	150%		80.6%		60.0%	15
INS	20%		221		20%	D	95%		54.8%		20.0%	
IRN	19%		226		19%	D					19.0%	
JAP	234%	223	223	334%	334%	I		575		172.5	0.0%	172.5
MLY		33.5	222	15%	15%	D	15%			33.5	0.0%	33.5
NEP	10%		292		10%	D	60%		37.0%		10.0%	
PAK	30%		222		30%	D	150%		80.6%		30.0%	
PNG	70%		217		70%	D	75%		46.3%		46.3%	
PHI	65%		221		65%	D	65%		40.1%		40.1%	
SOK	3%		223		3%	I	18%		9.2%		3.0%	
THA	65%		221		65%	D	94%		54.2%		54.2%	
FIJ	27%		215		27%	D	40%		24.7%		24.7%	

Sources: FAPRI, 2006; Banse et al., 2007; USDA (various years); UNCTAD, 2007; ITC (2007); WTO, 2007; Elobeid and Beghin, 2005; Briner, 2006; Sandrey and Vink, 2007; Fiji Islands Revenue and Customs Authority (2007); own adjustments and simulations.

Remarks: Romania and Bulgaria are not included since they join the EU in 2007. Swiss tariff is amended by several duties which are also payable by domestic producers. The overall amount of these duties is not reduced under Doha.

Annex IV continued: Trade flows in the WTO Scenario

Scheme	Origin	Destination					
		ALB	BOS	EUR	BUL	ROM	NOR
Domestic	ALB	0.0022					
Domestic	EUR			15.3154			
Domestic	BUL				0.0024		
Domestic	ROM					0.0352	
EBA	ETH			0.0403	0.0500	0.2470	
EBA	MAL			0.0462	0.0021	0.0041	
EBA	MOZ			0.0482	0.0221	0.0153	
EBA	ZAM			0.0644	0.0232	0.0105	
MFN	BRA	0.0909	0.1402	1.9018			0.1936
CXL	CUB			0.0543			
CXL	GUA			0.0037			
CXL	BRA			0.0220	0.1828	0.3033	
CXL	AUS			0.0091			
Balkans	ALB			0.0013			
Balkans	REU			0.0053			
ACP	MAL			0.0358			
ACP	MAU			0.4021			
ACP	MOZ			0.0206			
ACP	SWA			0.2034			
ACP	ZAM			0.0248			
ACP	ZIM			0.0403			
ACP	BAR			0.0103			
ACP	BEL			0.0687			
ACP	JAM			0.0040			
ACP	STK			0.0129			
ACP	GUY			0.2667			
ACP	FIJ			0.2187			

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex IV continued: Trade flows in the WTO Scenario

Scheme	Origin	Destination					
		RUS	SER	SWI	TUR	ALG	BEN
Domestic	RUS	2.5233					
Domestic	SER		0.3604				
Domestic	SWI			0.0960			
Domestic	TUR				1.6369		
Domestic	BEN						0.0034
MFN	BRA	3.5344		0.3774	0.5465	1.2329	0.0346
MFN	REU				0.0351		
		BUR	CDR	CON	COT	EGY	ETH
Domestic	BUR	0.0414					
Domestic	CDR		0.0646				
Domestic	CON			0.0554			
UEMOA/Domestic	COT	0.0310			0.0831		
Domestic	EGY					1.7118	
COMESA	ZAM		0.0304				
MFN	BRA			0.0087	0.1511	1.0831	0.3027
		GAB	GUI	KEN	MAD	MAL	MAU
Domestic	GAB	0.0222					
Domestic	GUI		0.0269				
Domestic	KEN			0.5345			
Domestic	MAD				0.0255		
Domestic	MAL					0.1574	
Domestic	MAU						0.0451
COMESA	ZIM				0.0307		
MFN	ARG			0.0011			
MFN	BRA		0.0928	0.2320	0.0871		
COMESA	MAL			0.0060			
COMESA	ZAM			0.0070			
COMESA	ZIM			0.0060			
		MLI	MOR	MOZ	NIG	SAC	SAF
UEMOA	COT	0.0253					
Domestic	MLI	0.0355					
Domestic	MOR		0.5008				
Domestic	MOZ			0.1550			
Domestic	NIG				0.0115		
Domestic	SAF						1.6955
UEMOA	SEN	0.0416					
SACU	SWA					0.2320	
MFN	ARG		0.0200				
MFN	BRA		0.8027		1.2126		
		SEN	SRL	SUD	SWA	TAN	TOG
Domestic	SEN	0.0528					
Domestic	SRL		0.0059				
Domestic	SUD			0.8021			
Domestic	SWA				0.0252		
Domestic	TAN					0.2464	
COMESA	ZIM			0.0227			
MFN	ARG					0.0164	
MFN	BRA	0.1372	0.0198			0.2101	0.0554

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex IV continued: Trade flows in the WTO Scenario

Scheme	Origin	Destination					
		UGA	ZAM	ZIM	BAR	BEL	CAN
Domestic	UGA	0.1838					
Domestic	ZAM		0.1184				
COMESA/Domestic	ZIM	0.0424		0.3217			
Domestic	BAR				0.0181		
Domestic	BEL					0.0126	
Domestic	CAN						0.0750
MFN	CUB						0.2364
MFN	GUA						1.1058
		COR	CUB	DOM	ELS	GUA	HAI
CARICOM	BEL						0.0150
Domestic	COR	0.2548					
Domestic/MFN	CUB		0.6689				0.1821
Domestic	DOM			0.3517			
Domestic	ELS				0.2410		
Domestic	GUA					0.7249	
		HON	JAM	MEX	NIC	PAN	STK
MFN	CUB			0.1777			
Domestic	HON	0.2725					
Domestic	JAM		0.1294				
Domestic	MEX			5.3864			
Domestic	NIC				0.2091		
Domestic	PAN					0.1315	
Domestic	STK						0.0053
MFN	COL			0.2287			

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex IV continued: Trade flows in the WTO Scenario

Scheme	Origin	Destination					
		TRI	USA	ARG	BOL	BRA	CHL
Domestic	UB		2.2093				
Domestic	UC		2.9669				
MFN	COR		0.1137				
MFN	HON		0.0859				
Domestic	TRI	0.0265					
Domestic	ARG			1.7494			
Domestic/MFN	BOL				0.2756		0.0053
MFN/Domestic	BRA	0.0235	1.3276			11.1961	
Domestic	CHL						0.4906
MFN	COL		0.3853				0.1437
CARICOM	GUY	0.0240					
MFN	RCA		0.0440				
TRQ	SAF		0.0625				
TRQ	SWA		0.0436				
TRQ	BEL		0.0185				
TRQ	CAN		0.0328				
TRQ	COR		0.0410				0.0015
TRQ	DOM		0.1415				
TRQ	ELS		0.0709				0.0015
TRQ	GUA		0.1306				0.0215
TRQ	HON		0.0272				
TRQ	NIC		0.0572				
TRQ	PAN		0.0095				
TRQ	ARG		0.1173				0.0346
TRQ	BOL		0.0135				0.0120
TRQ	BRA		0.3954				0.0177
TRQ	COL		0.0656				0.0162
TRQ	ECU		0.0301				
TRQ	PER		0.0685				
TRQ	PNG		0.0067				
TRQ	THA		0.0381				
TRQ	AUS		0.2266				
CAFTA	COR		0.0119				
CAFTA	DOM		0.0099				
CAFTA	ELS		0.0297				
CAFTA	GUA		0.0402				
CAFTA	HON		0.0087				
CAFTA	NIC		0.0239				
		COL	ECU	GUY	PAR	PER	SUR
Preferential	BOL				0.0311		
Preferential	BRA			0.0244			0.0181
Domestic/ANDEAN	COL	1.7428				0.1907	
Domestic	ECU		0.4769				
Domestic	PAR				0.1162		
Domestic	PER					0.8096	
Domestic	SUR						0.0050

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex IV continued: Trade flows in the WTO Scenario

Scheme	Origin	Destination					
		URU	VEN	BAN	CHN	IND	INS
MFN	SAF			0.7412			
MFN	SWA			0.2123			
MFN	ARG	0.1118					
MFN	COL		0.2997				
Domestic	URU	0.0081					
Domestic	VEN		0.6506				
Domestic	BAN			0.1350			
Domestic	CHN				10.2325		
Domestic	IND					21.9972	
Domestic	INS						2.4297
MFN	THA				1.1477		
MFN	AUS						1.7122
TRQ	CUB				0.4500		
		IRN	JAP	MLY	NEP	PAK	PNG
MFN	SAF	0.0440				0.0018	
MFN	SWA	0.0070			0.0010	0.0049	
MFN	ELS		0.2687				
MFN	NIC		0.2034				
MFN	ARG	0.2898				0.0031	
MFN	BRA				0.0013	0.8262	
Domestic	IRN	1.3887					
Domestic	MLY			0.0742			
Domestic	NEP				0.1355		
Domestic	PAK					3.9313	
MFN/Domestic	PNG		0.0058				0.0367
MFN	THA		1.0119				
MFN	AUS		0.8194	1.1827			
MFN	REU	0.4989					
TRQ	FIJ		0.0422				
		PHI	SOK	THA	AUS	FIJ	REU
Domestic	PHI	2.2587					
MFN/Domestic	THA		1.2241	2.4343			
Domestic	AUS				1.2090		
Domestic	FIJ					0.0632	
Domestic	REU						2.2789
		RNE	RAF	RCA	RSA	REA	RSO
MFN	SAF				0.0432		
MFN	SWA				0.0019		
MFN	ARG		0.0108		0.0018		
MFN	BRA	4.6323	0.4103		2.3478		
MFN	THA					0.9132	
MFN	AUS						1.1090
Domestic	RNE	0.1428					
Domestic	RAF		0.5220				
Domestic	RCA			0.0352			
Domestic	RSA				0.1801		
Domestic	REA					0.0940	
Domestic	RSO						1.1717

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex V: Results of the EU Liberalization Scenario

	Supply mill MT	Demand mill MT	Producer Price €/ ton	Consumer Price €/ ton
AT	0.1272		296	
BE	0.1964		296	
CZ	0.2485		296	
DK	0.0081		296	
ES			300	
FI	0.0238		296	
FR	1.3093		296	
GE	1.0839		296	
GR			345	
HU	0.1772		296	
IE				
IT			332	
LT	0.0227		296	
LV				
NL	0.2791		296	
PL	0.5647		296	
PT			327	
SI				
SK	0.0413		296	
SW	0.2619		296	
UK	0.6808		296	
ALB	0.0037	0.0922	329	344
BOS		0.1394		421
BUL	0.0015	0.2869	302	317
EUR	5.025	19.1862		306
NOR		0.1881		389
ROM	0.0205	0.6248	302	317
RUS	2.6377	6.028	392	407
SER	0.3604	0.3604	321	336
SWI	0.2023	0.4544	525	650
TUR	2.1621	2.1621	611	626
ALG		1.2223		328
BEN	0.0035	0.0376	352	367
BUR	0.0425	0.0719	427	442
CDR	0.0649	0.0949	318	333
CON	0.0587	0.0631	381	396
COT	0.1438	0.2321	351	366
EGY	1.764	2.771	329	344
ETH	0.339	0.3021	299	314
GAB	0.0222	0.0222	332	347
GUI	0.0277	0.1186	351	366
KEN	0.5954	0.7623	590	605
MAD	0.0262	0.1421	353	368
MAL	0.2531	0.1571	224	239
MAU	0.4353	0.0455	289	304
MLI	0.0364	0.1016	427	442
MOR	0.512	1.3119	544	559
MOZ	0.2625	0.1548	294	309
NIG	0.0119	1.2132	437	452
SAC		0.2221		643
SAF	2.6891	1.5284	238	642
SEN	0.0973	0.1883	351	366
SRL	0.0061	0.0255	351	366
SUD	0.8197	0.8197	352	367
SWA	0.773	0.0215	168	775
TAN	0.2682	0.4613	590	605
TOG		0.0549		367

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex V continued: Results of the EU Liberalization Scenario

	Supply mill MT	Demand mill MT	Producer Price €/ ton	Consumer Price €/ ton
UGA	0.1944	0.2229	514	522
ZAM	0.2805	0.1181	224	239
ZIM	0.4869	0.3173	221	236
BAR	0.0257	0.0187	234	249
BEL	0.1093	0.0128	234	249
CAN	0.1151	1.4107	302	312
COR	0.4362	0.2525	230	245
CUB	1.8001	0.663	229	244
DOM	0.5366	0.3451	331	346
ELS	0.6291	0.239	226	241
GUA	2.0911	0.7184	227	242
HAI		0.1994		308
HON	0.4061	0.2703	230	245
JAM	0.1298	0.1304	292	307
MEX	5.6973	5.6973	470	485
NIC	0.5083	0.2073	226	241
PAN	0.1511	0.1289	336	351
STK	0.0165	0.0055	234	249
TRI	3.8379		391	
UB	3.2236		382	
UC	0.0254	0.075	291	306
USA		8.7858		414
ARG	2.4503	1.7299	228	243
BOL	0.3497	0.2728	211	226
BRA	37.2545	11.0829	229	244
CHL	0.4718	0.732	304	400
COL	3.176	1.7263	226	241
ECU	0.5002	0.4788	249	264
GUY	0.2758	0.0248	233	248
PAR	0.1217	0.1453	350	365
PER	0.9011	0.9927	285	300
SUR	0.0048	0.0235	290	305
URU	0.0084	0.1187	298	313
VEN	0.6772	0.9392	329	344
BAN	0.138	1.0811	376	391
CHN	10.4307	11.7609	353	368
IND	21.9972	21.9972	410	427
INS	2.482	4.115	356	371
IRN	1.4273	2.2098	366	381
JAP	1.3118	2.1751	1148	1158
MLY	0.0756	1.2495	326	341
NEP	0.1373	0.1373	401	416
PAK	4.042	4.7268	395	410
PNG	0.0505	0.0364	236	251
PHI	2.3749	2.2695	317	332
SOK		1.2131		321
THA	6.931	2.4162	241	292
AUS	6.5993	1.1966	245	255
FIJ	0.2979	0.0648	233	248
REU	3.037	2.2408	238	253
RNE	0.1472	4.7446	300	315
RAF	0.5705	0.9253	354	369
RCA	0.0814	0.0349	229	244
RSA	0.1851	2.5523	306	321
REA	0.0958	1.0011	296	311
RSO	1.1968	2.2654	298	313

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex V continued: Trade flows in the EU Liberalization Scenario

Scheme	Origin	Destination					
		ALB	BOS	EUR	BUL	ROM	NOR
Domestic	ALB	0.0037					
Domestic	EUR			4.7729			
Domestic	BUL				0.0015		
Domestic	ROM					0.0205	
MFN	COR			0.0002			
MFN	CUB			0.0052			
MFN	NIC				0.0001	0.0001	
MFN	BRA	0.0885	0.1394	13.5834	0.0798	0.0731	
MFN	COL			0.8243			
MFN	REU				0.1878	0.5202	
MFN	RCA			0.0002	0.0177	0.0110	
GSP	ETH						0.0369
GSP	MAL						0.0450
GSP	MOZ						0.1011
GSP	ZAM						0.0052

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex V continued: Trade flows in the EU Liberalization Scenario

Scheme	Origin	Destination					
		RUS	SER	SWI	TUR	ALG	BEN
MFN	EUR			0.2521			
Domestic	RUS	2.6377					
Domestic	SER		0.3604				
Domestic	SWI			0.2023			
Domestic	TUR				2.1621		
Domestic	BEN						0.0035
MFN	COR					0.1104	
MFN	CUB					0.6510	
MFN	BRA	3.3903				0.4609	0.0342
		BUR	CDR	CON	COT	EGY	ETH
Domestic	BUR	0.0425					
Domestic	CDR		0.0649				
Domestic	CON			0.0587			
UEMOA/Domestic	COT	0.0295			0.1054		
Domestic	EGY					1.7640	
Domestic	ETH						0.3021
COMESA	ZAM		0.0300				
MFN	BRA			0.0044	0.1267	1.0070	
		GAB	GUI	KEN	MAD	MAL	MAU
Domestic	GAB	0.0222					
Domestic	GUI		0.0277				
Domestic	KEN			0.5954			
Domestic	MAD				0.0262		
Domestic	MAL					0.1571	
COMESA	MAU				0.1159		0.0455
EAC	UGA			0.1058			
MFN	ARG			0.0001			
MFN	BRA		0.0909	0.0420			
COMESA	MAL			0.0060			
COMESA	ZAM			0.0070			
COMESA	ZIM			0.0060			
		MLI	MOR	MOZ	NIG	SAC	SAF
UEMOA	COT	0.0089					
Domestic	MLI	0.0364					
Domestic	MOR		0.5120				
Domestic	MOZ			0.1548			
Domestic	NIG				0.0119		
Domestic	SAF						1.3907
UEMOA	SEN	0.0563					
SACU	SWA					0.2221	
MFN	ELS		0.2331				
MFN	HON		0.0767				
MFN	NIC		0.1960				
MFN	ARG		0.1033				
MFN	BRA		0.1338		1.2013		
MFN	GUY		0.0394				
MFN	RCA		0.0176				
SADC	ZAM						0.0702
SADC	ZIM						0.0675

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex V continued: Trade flows in the EU Liberalization Scenario

Scheme	Origin	Destination					
		SEN	SRL	SUD	SWA	TAN	TOG
MFN	MAL					0.0383	
Domestic	SEN	0.0410					
Domestic	SRL		0.0061				
Domestic	SUD			0.8197			
Domestic	SWA				0.0215		
Domestic	TAN					0.2682	
EAC	UGA					0.0886	
MFN	ZAM					0.0500	
MFN	ARG					0.0001	
MFN	BRA	0.1473	0.0193			0.0161	0.0549
		UGA	ZAM	ZIM	BAR	BEL	CAN
COMESA	MAU	0.2229					
Domestic	ZAM		0.1181				
Domestic	ZIM			0.3173			
Domestic	BAR				0.0187		
Domestic	BEL					0.0128	
Domestic	CAN						0.0772
MFN	ELS						0.0754
MFN	GUA						1.2179
MFN	NIC						0.0402
		COR	CUB	DOM	ELS	GUA	HAI
Domestic/MFN	COR	0.2578		0.0601			
Domestic/MFN	CUB		0.6769	0.0263			0.1968
Domestic	DOM			0.2208			
Domestic	ELS				0.2436		
Domestic	GUA					0.7337	
MFN/Domestic	HON			0.0437			
		HON	JAM	MEX	NIC	PAN	STK
CARICOM	BEL		0.0074				
Domestic	HON	0.2703					
Domestic	JAM		0.1231				
Domestic	MEX			5.6973			
Domestic	NIC				0.2073		
Domestic	PAN					0.1289	
Domestic	STK						0.0055

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex V continued: Trade flows in the EU Liberalization Scenario

Scheme	Origin	Destination					
		TRI	USA	ARG	BOL	BRA	CHL
Domestic	UB		3.8379				
Domestic	UC		3.2236				
MFN	BAR	0.0070					
Domestic	TRI	0.0254					
Domestic	ARG			1.7299			
Domestic/MFN	BOL				0.2728		0.0256
Domestic	BRA					11.0829	
Domestic	CHL						0.4718
MFN	COL						0.1296
CARICOM	GUY	0.0426					
TRQ	MAL		0.0067				
TRQ	MOZ		0.0067				
TRQ	SAF		0.0445				
TRQ	SWA		0.0310				
TRQ	ZIM		0.0232				
TRQ	BEL		0.0214				
TRQ	CAN		0.0379				
TRQ	COR		0.0291				0.0015
TRQ	DOM		0.2730				
TRQ	ELS		0.0504				0.0015
TRQ	GUA		0.0930				0.0215
TRQ	HON		0.0194				
TRQ	JAM		0.0067				
TRQ	NIC		0.0407				
TRQ	PAN		0.0222				
TRQ	STK		0.0067				
TRQ	ARG		0.0834				0.0346
TRQ	BOL		0.0157				0.0120
TRQ	BRA		0.2809				0.0177
TRQ	COL		0.0465				0.0162
TRQ	ECU		0.0214				
TRQ	GUY		0.0232				
TRQ	PER		0.0794				
TRQ	URU		0.0067				
TRQ	PNG		0.0067				
TRQ	PHI		0.1054				
TRQ	THA		0.0270				
TRQ	AUS		0.1611				
TRQ	FIJ		0.0140				
TRQ	REA		0.0150				
CAFTA	COR		0.0119				
CAFTA	DOM		0.0109				
CAFTA	ELS		0.0297				
CAFTA	GUA		0.0402				
CAFTA	HON		0.0087				
CAFTA	NIC		0.0239				
		COL	ECU	GUY	PAR	PER	SUR
MFN	BOL				0.0236		
Domestic/ANDEAN	COL	1.7263				0.1710	
Domestic	ECU		0.4788				
Domestic/CARICOM	GUY			0.0248			0.0186
Domestic	PAR				0.1217		
Domestic	PER					0.8217	
Domestic	SUR						0.0048

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex V continued: Trade flows in the EU Liberalization Scenario

Scheme	Origin	Destination					
		URU	VEN	BAN	CHN	IND	INS
MFN	GUA		0.0001				
MFN	ARG	0.1170					
MFN	COL		0.2619				
Domestic	URU	0.0017					
Domestic	VEN		0.6772				
Domestic	BAN			0.1380			
Domestic	CHN				10.4307		
Domestic	IND					21.9972	
Domestic	INS						2.4820
MFN	THA			0.0969	0.8802		
MFN	AUS			0.8462			1.6330
TRQ	CUB				0.4500		
		IRN	JAP	MLY	NEP	PAK	PNG
MFN	SAF	0.0000				0.0000	
MFN	SWA	0.1835				0.1497	
MFN	ARG	0.1403				0.1126	
MFN	BRA					0.1978	
Domestic	IRN	1.4273					
Domestic	JAP		1.3118				
Domestic	MLY			0.0756			
Domestic	NEP				0.1373		
Domestic	PAK					4.0420	
MFN/Domestic	PNG			0.0074			0.0364
MFN	THA	0.2055	0.7141			0.1345	
MFN	AUS	0.1650		1.1248		0.0902	
MFN	FIJ		0.1070	0.0416			
MFN	REU	0.0882					
TRQ	FIJ		0.0422				
		PHI	SOK	THA	AUS	FIJ	REU
Domestic	PHI	2.2695					
MFN/Domestic	THA		1.2131	2.4162			
Domestic	AUS				1.1966		
Domestic	FIJ					0.0648	
Domestic	REU						2.2408
		RNE	RAF	RCA	RSA	REA	RSO
MFN	MAU		0.0510				
MFN	SAF				1.2538		
MFN	SWA				0.1652		
MFN	ZIM		0.0729				
MFN	ARG		0.0206		0.1084		
MFN	BRA	4.5974	0.2103		0.1740		
MFN	PNG						0.0000
MFN	THA				0.3233	0.9203	
MFN	AUS				0.3423		1.0403
MFN	FIJ						0.0283
Domestic	RNE	0.1472					
Domestic	RAF		0.5705				
Domestic	RCA			0.0349			
Domestic	RSA				0.1851		
Domestic	REA					0.0808	
Domestic	RSO						1.1968

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex VI: Results of the Full Liberalization Scenario

	Supply mill MT	Demand mill MT	Producer Price €/ ton	Consumer Price €/ ton
AT	0.2477		329	
BE	0.4801		329	
CZ	0.3445		329	
DK	0.1502		329	
ES	0.1952		329	
FI	0.0448		329	
FR	2.5315		329	
GE	2.2852		329	
GR			350	
HU	0.2752		329	
IE			329	
IT			337	
LT	0.0483		329	
LV			329	
NL	0.513		329	
PL	1.1316		329	
PT			330	
SI			329	
SK	0.0824		329	
SW	0.3357		329	
UK	0.9475		329	
ALB	0.0038	0.0921	333	348
BOS		0.1395		418
BUL	0.0019	0.2848	335	350
EUR	9.6128	19.0122		339
NOR		0.192		341
ROM	0.0262	0.6201	335	350
RUS	2.3772	6.0977	334	349
SER	0.3648	0.3599	327	342
SWI		0.5033	373	339
TUR		2.2913	503	350
ALG		1.2155		346
BEN	0.0034	0.0379	328	343
BUR	0.0415	0.0724	397	412
CDR	0.0657	0.0946	329	344
CON	0.0559	0.064	328	343
COT	0.1405	0.2337	327	342
EGY	1.7718	2.7675	333	348
ETH	0.3487	0.2997	325	340
GAB	0.0222	0.0223	329	344
GUI	0.0271	0.1194	327	342
KEN	0.4924	0.8055	333	348
MAD	0.0257	0.143	332	347
MAL	0.2636	0.1553	253	268
MAU	0.4282	0.0457	275	290
MLI	0.0356	0.1023	397	412
MOR	0.4343	1.3357	331	346
MOZ	0.2566	0.1558	274	289
NIG	0.0108	1.2471	328	343
SAC		0.2356		292
SAF	2.809	1.6568	271	286
SEN	0.0951	0.1896	327	342
SRL	0.006	0.0256	327	342
SUD	0.8103	0.8225	339	354
SWA	0.821	0.0244	201	216
TAN	0.2209	0.488	329	344
TOG		0.0553		343

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex VI continued: Results of the Full Liberalization Scenario

	Supply mill MT	Demand mill MT	Producer Price €/ ton	Consumer Price €/ ton
UGA	0.179	0.228	401	416
ZAM	0.2922	0.1168	253	268
ZIM	0.4741	0.3197	204	219
BAR	0.0268	0.0184	267	282
BEL	0.1145	0.0126	269	284
CAN	0.1209	1.4058	327	337
COR	0.4587	0.2489	268	283
CUB	1.5728	0.6534	267	282
DOM	0.5012	0.352	268	283
ELS	0.662	0.2355	264	279
GUA	2.1975	0.7082	264	279
HAI		0.1973		341
HON	0.4276	0.2663	269	284
JAM	0.1303	0.1303	296	311
MEX	5.0696	5.8972	328	343
NIC	0.5356	0.2042	265	280
PAN	0.1404	0.1316	268	283
STK	0.0172	0.0054	267	282
TRI	0.0263	0.0742	324	339
UB	1.7567		327	
UC	2.8843		327	
USA		8.8697		337
ARG	2.5617	1.7078	261	276
BOL	0.3687	0.2686	248	263
BRA	41.0943	10.9545	262	277
CHL	0.4926	0.7442	324	339
COL	3.3382	1.7017	263	278
ECU	0.5114	0.4757	266	281
GUY	0.2881	0.0244	266	281
PAR	0.1187	0.1463	324	339
PER	0.938	0.9812	322	337
SUR	0.005	0.0232	323	338
URU	0.0086	0.118	317	332
VEN	0.6744	0.9403	324	339
BAN	0.1334	1.0924	337	352
CHN	10.2346	11.8294	332	347
IND	20.7352	22.4126	339	354
INS	2.4302	4.1417	332	347
IRN	1.3981	2.2239	342	357
JAP		2.3922	674	342
MLY	0.0762	1.2467	333	348
NEP	0.1373	0.1373	401	416
PAK	3.8554	4.7958	339	354
PNG	0.0528	0.036	271	286
PHI	2.2937	2.2937	283	298
SOK		1.1974		348
THA	7.2423	2.416	277	292
AUS	7.1594	1.177	279	289
FIJ	0.3118	0.0639	269	284
REU	3.3079	2.1977	271	286
RNE	0.1524	4.7089	333	348
RAF	0.5574	0.9299	330	345
RCA	0.0858	0.0344	269	284
RSA	0.1912	2.5259	339	354
REA	0.0993	0.9895	332	347
RSO	1.2383	2.2408	332	347

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex VI continued: Trade flows in the Full Liberalization Scenario

Scheme	Origin	Destination					
		ALB	BOS	EUR	BUL	ROM	NOR
Domestic	ALB	0.0038					
Domestic	EUR			9.1095			
Domestic	BUL				0.0019		
Domestic	ROM					0.0262	
MFN	SER		0.0048				
MFN	BRA	0.0884	0.1347	9.9027	0.2004	0.5236	0.1920
MFN	REU				0.0825	0.0703	

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex VI continued: Trade flows in the Full Liberalization Scenario

Scheme	Origin	Destination					
		RUS	SER	SWI	TUR	ALG	BEN
MFN	EUR			0.5033			
Domestic	RUS	2.3772					
Domestic	SER		0.3599				
Domestic	BEN						0.0034
MFN	BRA	3.7204			1.4857	1.2155	0.0345
MFN	REU				0.8056		
		BUR	**CDR**	**CON**	**COT**	**EGY**	**ETH**
Domestic	BUR	0.0415					
Domestic	CDR		0.0657				
Domestic	CON			0.0559			
Domestic	COT				0.1405		
Domestic	EGY					1.7718	
Domestic	ETH						0.2997
MFN	ZAM		0.0167				
MFN	ARG		0.0121				
MFN	BRA	0.0310		0.0081	0.0932	0.9957	
		GAB	**GUI**	**KEN**	**MAD**	**MAL**	**MAU**
Domestic	GAB	0.0222					
Domestic	GUI		0.0271				
Domestic	KEN			0.4924			
Domestic	MAD				0.0257		
Domestic	MAL					0.1553	
Domestic	MAU						0.0457
MFN	ARG	0.0001			0.0382		
MFN	BRA		0.0923	0.3130	0.0791		
		MLI	**MOR**	**MOZ**	**NIG**	**SAC**	**SAF**
Domestic	MLI	0.0356					
Domestic	MOR		0.4343				
Domestic	MOZ			0.1558			
Domestic	NIG				0.0108		
Domestic	SAF						1.6568
Domestic	SWA					0.2356	
MFN	ARG		0.2848				
MFN	BRA	0.0668	0.6070		1.2363		
MFN	GUY		0.0096				
		SEN	**SRL**	**SUD**	**SWA**	**TAN**	**TOG**
MFN	MAL					0.1084	
Domestic	SEN	0.0951					
Domestic	SRL		0.0060				
Domestic	SUD			0.8103			
MFN/Domestic	SWA			0.0096	0.0244		
Domestic	TAN					0.2209	
MFN	ZAM					0.1587	
MFN	BRA	0.0945	0.0197				0.0553
MFN	REU			0.0026			

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex VI continued: Trade flows in the Full Liberalization Scenario

Scheme	Origin	Destination					
		UGA	ZAM	ZIM	BAR	BEL	CAN
MFN	ETH	0.0490					
Domestic	UGA	0.1790					
Domestic	ZAM		0.1168				
Domestic	ZIM			0.3197			
Domestic	BAR				0.0184		
Domestic	BEL					0.0126	
Domestic	CAN						0.1209
MFN	GUA						1.2849
		COR	CUB	DOM	ELS	GUA	HAI
MFN	BAR						0.0040
Domestic	COR	0.2489					
Domestic/MFN	CUB		0.6534				0.0918
Domestic/MFN	DOM			0.3520			0.0393
Domestic	ELS				0.2355		
Domestic	GUA					0.7082	
MFN	STK						0.0036
MFN	GUY						0.0586
		HON	JAM	MEX	NIC	PAN	STK
MFN	CUB			0.8276			
Domestic	HON	0.2663					
Domestic	JAM		0.1303				
Domestic	MEX			5.0696			
Domestic	NIC				0.2042		
Domestic	PAN					0.1316	
Domestic	STK						0.0054

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex VI continued: Trade flows in the Full Liberalization Scenario

Scheme	Origin	Destination					
		TRI	USA	ARG	BOL	BRA	CHL
Domestic	UB		1.7567				
Domestic	UC		2.8843				
MFN	BAR	0.0043					
MFN	BEL		0.1019				
MFN	COR		0.2098				
MFN	DOM		0.1098				
MFN	ELS		0.4265				
MFN	GUA		0.1148				
MFN	HON		0.1613				
MFN	NIC		0.3314				
MFN	PAN		0.0088				
MFN	STK		0.0082				
Domestic	TRI	0.0263					
Domestic	ARG			1.7078			
Domestic	BOL				0.2686		0.0725
MFN/Domestic	BRA		1.2975			10.9545	
Domestic	CHL						0.4926
MFN	COL		1.2379				0.1792
MFN	ECU		0.0357				
MFN	GUY	0.0436	0.1337				
MFN	RCA		0.0514				

Scheme	Origin	COL	ECU	GUY	PAR	PER	SUR
MFN	BOL				0.0276		
Domestic/MFN	COL	1.7017				0.0432	
Domestic	ECU		0.4757				
Domestic/MFN	GUY			0.0244			0.0182
Domestic	PAR				0.1187		
Domestic	PER					0.9380	
MFN	SUR						0.0050

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex VI continued: Trade flows in the Full Liberalization Scenario

Scheme	Origin	Destination					
		URU	VEN	BAN	CHN	IND	INS
MFN	SAF					0.4624	
MFN	SWA					0.2137	
MFN	GUA		0.0896				
MFN	ARG	0.1094				0.2468	
MFN	BRA					0.5993	
MFN	COL		0.1763				
Domestic	URU	0.0086					
Domestic	VEN		0.6744				
Domestic	BAN			0.1334			
Domestic	CHN				10.2346		
Domestic	IND					20.7352	
Domestic	INS						2.4302
MFN	THA				1.5948		
MFN	AUS			0.9590		0.1553	1.7115
		IRN	JAP	MLY	NEP	PAK	PNG
MFN	MAU	0.3825					
MFN	MOZ	0.1008					
MFN	SAF	0.0390				0.0343	
MFN	SWA					0.1548	
MFN	ZIM	0.1544					
MFN	ARG					0.0021	
MFN	BRA					0.7491	
Domestic	IRN	1.3981					
Domestic	MLY			0.0762			
Domestic	NEP				0.1373		
Domestic	PAK					3.8554	
MFN/Domestic	PNG		0.0168				0.0360
MFN	THA		1.1440				
MFN	AUS		0.9836	1.1705			
MFN	FIJ		0.2478				
MFN	REU	0.1492					
		PHI	SOK	THA	AUS	FIJ	REU
Domestic	PHI	2.2937					
MFN/Domestic	THA		1.1974	2.4160			
Domestic	AUS				1.1770		
Domestic	FIJ					0.0639	
Domestic	REU						2.1977
		RNE	RAF	RCA	RSA	REA	RSO
MFN	SAF				0.6165		
MFN	SWA				0.1828		
MFN	ARG		0.0385		0.1219		
MFN	BRA	4.5565	0.3341		1.4134		
MFN	THA					0.8902	
MFN	AUS						1.0024
Domestic	RNE	0.1524					
Domestic	RAF		0.5574				
Domestic	RCA			0.0344			
Domestic	RSA				0.1912		
Domestic	REA					0.0993	
Domestic	RSO						1.2383

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex VII: Results of the Baseline Scenario under the First Sensitivity Analysis (BDI= 10,000)

	Supply mill MT	Demand mill MT	Producer Price €/ ton	Consumer Price €/ ton
AT	0.3873		365	
BE	0.8198		362	
CZ	0.4549		365	
DK	0.4207		386	
ES	0.8809		440	
FI	0.122		440	
FR	4.0325		365	
GE	3.6555		360	
GR	0.1897		440	
HU	0.4017		370	
IE				
IT	0.7787		423	
LT	0.103		404	
LV				
NL	0.8646		369	
PL	1.6719		359	
PT	0.0445		427	
SI				
SK	0.2074		439	
SW	0.3257		321	
UK	1.1386		345	
ALB	0.0034	0.0931	290	305
BOS		0.1405		382
BUL	0.0031	0.2792	441	456
EUR	16.4994	18.5448		450
NOR		0.1861		416
ROM	0.0472	0.608	441	456
RUS	2.5641	6.047	376	391
SER	0.3604	0.3604	321	336
SWI	0.2023	0.4511	525	682
TUR	2.1621	2.1621	611	626
ALG		1.2346		296
BEN	0.0034	0.0381	336	329
BUR	0.0412	0.0726	389	404
CDR	0.0661	0.095	335	329
CON	0.0565	0.0638	339	354
COT	0.1384	0.2347	313	328
EGY	1.7306	2.7862	311	326
ETH	0.3522	0.3034	335	302
GAB	0.0223	0.0222	336	351
GUI	0.0274	0.1199	338	328
KEN	0.5733	0.7707	526	541
MAD	0.0257	0.1435	332	334
MAL	0.2663	0.1548	261	276
MAU	0.4661	0.0447	355	361
MLI	0.0353	0.1026	389	404
MOR	0.5018	1.3225	512	527
MOZ	0.2732	0.1532	331	344
NIG	0.0114	1.2268	390	405
SAC		0.2254		527
SAF	2.5136	1.5588	194	527
SEN	0.0962	0.1904	339	328
SRL	0.0061	0.0258	338	328
SUD	0.8197	0.8197	352	367
SWA	0.6993	0.0221	124	578
TAN	0.2582	0.4665	526	541
TOG		0.0555		329

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex VII continued: Results of the Baseline Liberalization Scenario under the First Sensitivity Analysis

	Supply mill MT	Demand mill MT	Producer Price €/ ton	Consumer Price €/ ton
UGA	0.1957	0.2222	524	539
ZAM	0.2952	0.1164	261	276
ZIM	0.4773	0.3191	209	224
BAR	0.0295	0.0179	358	373
BEL	0.1159	0.0126	280	295
CAN	0.1088	1.4162	277	287
COR	0.4037	0.2582	181	196
CUB	1.7169	0.68	174	189
DOM	0.5224	0.3478	305	320
ELS	0.5802	0.2446	176	191
GUA	1.9152	0.7367	173	188
HAI		0.195		384
HON	0.3752	0.2764	180	195
JAM	0.1385	0.128	356	371
MEX	5.6973	5.6973	470	485
NIC	0.4688	0.2121	176	191
PAN	0.1468	0.1299	308	323
STK	0.019	0.0053	358	373
TRI	0.0273	0.0733	366	381
UB	3.8379		391	
UC	3.2236		382	
USA		8.7858		414
ARG	2.2576	1.7708	177	192
BOL	0.3381	0.2754	190	205
BRA	29.8343	11.3748	168	183
CHL	0.4493	0.7362	282	378
COL	2.9184	1.7685	174	189
ECU	0.5016	0.4784	251	266
GUY	0.2921	0.0245	278	278
PAR	0.1168	0.147	309	324
PER	0.8793	0.9999	264	279
SUR	0.0052	0.023	365	380
URU	0.0082	0.1197	272	287
VEN	0.6475	0.9516	286	301
BAN	0.1342	1.0904	344	359
CHN	10.1732	11.8512	326	341
IND	21.9972	21.9972	410	427
INS	2.4101	4.1522	324	339
IRN	1.3842	2.2307	332	347
JAP	1.1515	2.186	1076	1086
MLY	0.0737	1.2597	299	314
NEP	0.1349	0.138	379	394
PAK	3.9095	4.7754	355	370
PNG	0.0469	0.0372	187	202
PHI	2.3171	2.2867	293	308
SOK		1.2275		297
THA	6.593	2.4547	206	251
AUS	5.7345	1.2307	195	205
FIJ	0.3355	0.0625	341	356
REU	2.6073	2.319	188	203
RNE	0.1444	4.764	283	298
RAF	0.5494	0.9328	316	331
RCA	0.0756	0.0357	182	197
RSA	0.1791	2.5793	275	290
REA	0.0935	1.009	274	289
RSO	1.1623	2.2866	272	287

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex VIII: Results of the Full Liberalization Scenario under the First Sensitivity Analysis (BDI= 10,000)

	Supply mill MT	Demand mill MT	Producer Price €/ ton	Consumer Price €/ ton
AT	0.2931		341	
BE	0.5933		341	
CZ	0.3806		341	
DK	0.2069		341	
ES	0.279		341	
FI	0.0539		341	
FR	3.0033		341	
GE	2.7666		341	
GR			350	
HU	0.3119		341	
IE				
IT	0.0404		341	
LT	0.0577		341	
LV				
NL	0.6107		341	
PL	1.3417		341	
PT	0.0056		341	
SI				
SK	0.0977		341	
SW	0.3648		341	
UK	1.057		341	
ALB	0.0038	0.092	340	355
BOS		0.1393		425
BUL	0.0022	0.2834	359	374
EUR	11.4643	18.9533		351
NOR		0.1909		353
ROM	0.031	0.6172	359	374
RUS	2.4878	6.0672	359	374
SER	0.3692	0.3594	334	349
SWI		0.5006	373	351
TUR		2.2767	503	374
ALG		1.2116		358
BEN	0.0034	0.0378	338	353
BUR	0.0418	0.0723	407	422
CDR	0.0663	0.0943	338	353
CON	0.0564	0.0638	338	353
COT	0.1418	0.2331	337	352
EGY	1.8135	2.749	358	373
ETH	0.3487	0.2997	325	340
GAB	0.0222	0.0222	332	347
GUI	0.0273	0.1191	337	352
KEN	0.4969	0.8034	343	358
MAD	0.0259	0.1426	342	357
MAL	0.2664	0.1548	262	277
MAU	0.4209	0.0459	262	277
MLI	0.0359	0.1021	407	422
MOR	0.4416	1.3293	349	364
MOZ	0.2519	0.1566	260	275
NIG	0.0109	1.2438	338	353
SAC		0.2358		290
SAF	2.7992	1.6584	269	284
SEN	0.096	0.1891	337	352
SRL	0.006	0.0256	337	352
SUD	0.819	0.8199	351	366
SWA	0.8171	0.0245	199	214
TAN	0.2227	0.4869	338	353
TOG		0.0552		353

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex VIII continued: Results of the Full Liberalization Scenario under the First Sensitivity Analysis

	Supply mill MT	Demand mill MT	Producer Price €/ ton	Consumer Price €/ ton
UGA	0.179	0.228	401	416
ZAM	0.2953	0.1164	262	277
ZIM	0.4648	0.3215	193	208
BAR	0.0265	0.0185	258	273
BEL	0.1125	0.0127	256	271
CAN	0.1235	1.4037	338	348
COR	0.452	0.25	257	272
CUB	1.5378	0.6576	250	265
DOM	0.4945	0.3534	258	273
ELS	0.6514	0.2367	252	267
GUA	2.1509	0.7126	248	263
HAI		0.1965		357
HON	0.4203	0.2676	256	271
JAM	0.1303	0.1303	296	311
MEX	5.1349	5.8751	342	357
NIC	0.5263	0.2052	252	267
PAN	0.1382	0.1323	256	271
STK	0.017	0.0055	258	273
TRI	0.0266	0.0739	339	354
UB	1.8323		329	
UC	2.898		329	
USA		8.8671		339
ARG	2.5299	1.714	252	267
BOL	0.3764	0.2671	265	280
BRA	38.8263	11.0287	243	258
CHL	0.5084	0.7408	341	356
COL	3.2757	1.711	249	264
ECU	0.5019	0.4783	252	267
GUY	0.285	0.0245	258	273
PAR	0.118	0.1466	319	334
PER	0.9531	0.9766	339	354
SUR	0.0051	0.0231	338	353
URU	0.0087	0.1174	334	349
VEN	0.6752	0.94	326	341
BAN	0.1346	1.0893	348	363
CHN	10.3314	11.7954	343	358
IND	20.9273	22.3494	350	365
INS	2.4487	4.1321	341	356
IRN	1.4134	2.2164	355	370
JAP		2.3862	674	353
MLY	0.0768	1.2439	342	357
NEP	0.1373	0.1373	401	416
PAK	3.8911	4.7823	350	365
PNG	0.0518	0.0362	256	271
PHI	2.2937	2.2937	283	298
SOK		1.192		359
THA	7.219	2.4185	275	290
AUS	6.9207	1.1851	264	274
FIJ	0.3063	0.0643	255	270
REU	3.2452	2.2073	264	279
RNE	0.156	4.6853	358	373
RAF	0.5625	0.9281	340	355
RCA	0.0846	0.0345	258	273
RSA	0.193	2.5184	350	365
REA	0.1003	0.9865	343	358
RSO	1.2478	2.2353	341	356

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex IX: Results of the Baseline Scenario under the Second Sensitivity Analysis (ε*2)

	Supply mill MT	Demand mill MT	Producer Price €/ ton	Consumer Price €/ ton
AT	0.3873		365	
BE	0.8198		362	
CZ	0.4549		365	
DK	0.4207		386	
ES	0.6932		405	
FI	0.1017		405	
FR	4.0325		365	
GE	3.6555		360	
GR	0.126		405	
HU	0.4017		370	
IE				
IT	0.6415		405	
LT	0.103		404	
LV				
NL	0.8646		369	
PL	1.6719		359	
PT	0.0358		405	
SI				
SK	0.1738		405	
SW	0.3257		321	
UK	1.1386		345	
ALB	0.0034	0.0937	265	280
BOS		0.1412		357
BUL	0.0028	0.2808	408	423
EUR	16.0482	18.6747		415
NOR		0.1883		386
ROM	0.0416	0.6114	408	423
RUS	2.3366	6.0983	334	349
SER	0.3592	0.3592	337	352
SWI	0.2023	0.4542	525	652
TUR	1.9775	2.1811	559	574
ALG		1.2479		266
BEN	0.0028	0.0385	331	297
BUR	0.0407	0.0732	357	372
CDR	0.0712	0.0959	329	298
CON	0.0557	0.0645	305	320
COT	0.1364	0.2371	281	296
EGY	1.6751	2.8287	265	280
ETH	0.3881	0.3063	330	274
GAB	0.0233	0.0224	330	321
GUI	0.0294	0.1212	332	296
KEN	0.5649	0.7788	473	488
MAD	0.0272	0.145	326	302
MAL	0.3032	0.1552	255	270
MAU	0.3816	0.0452	349	326
MLI	0.0349	0.1034	357	372
MOR	0.4803	1.3398	465	480
MOZ	0.3008	0.1542	325	321
NIG	0.0113	1.2396	350	365
SAC		0.2266		491
SAF	2.5171	1.5698	181	491
SEN	0.1034	0.1924	333	296
SRL	0.0065	0.026	332	296
SUD	0.826	0.8245	331	346
SWA	0.7022	0.0224	111	516
TAN	0.2549	0.4713	473	488
TOG		0.0561		297

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex IX continued: Results of the Baseline Scenario under the Second Sensitivity Analysis

	Supply mill MT	Demand mill MT	Producer Price €/ ton	Consumer Price €/ ton
UGA	0.1938	0.2243	475	490
ZAM	0.3361	0.1167	255	270
ZIM	0.4865	0.3214	193	208
BAR	0.024	0.0181	355	340
BEL	0.1167	0.0126	264	279
CAN	0.1045	1.4234	247	257
COR	0.4093	0.2591	175	190
CUB	1.6696	0.6802	174	189
DOM	0.5118	0.3522	267	282
ELS	0.5925	0.2448	175	190
GUA	1.9604	0.7373	172	187
HAI		0.1976		337
HON	0.3818	0.2772	175	190
JAM	0.1283	0.1292	353	337
MEX	5.7118	5.7118	458	473
NIC	0.4779	0.2124	174	189
PAN	0.1383	0.1288	336	351
STK	0.0176	0.0053	355	338
TRI	0.0221	0.0742	354	340
UB	3.8379		391	
UC	3.2202		405	
USA		8.7853		415
ARG	2.2804	1.777	171	186
BOL	0.3347	0.2775	176	191
BRA	31.8173	11.3614	171	186
CHL	0.4242	0.7442	243	340
COL	2.9537	1.7738	169	184
ECU	0.4928	0.4834	225	240
GUY	0.2955	0.0247	267	249
PAR	0.1179	0.1471	307	322
PER	0.8542	1.014	228	243
SUR	0.0051	0.0232	323	338
URU	0.008	0.1213	238	253
VEN	0.643	0.9594	263	278
BAN	0.1363	1.101	324	326
CHN	10.0114	11.9732	293	308
IND	22.0723	22.0723	396	413
INS	2.3804	4.192	293	308
IRN	1.3649	2.2538	298	313
JAP	0.9214	2.2018	981	991
MLY	0.0723	1.2704	274	289
NEP	0.1335	0.1391	349	364
PAK	3.8584	4.8244	319	334
PNG	0.0478	0.0373	185	200
PHI	2.3611	2.2692	317	332
SOK		1.2471		269
THA	6.5665	2.4727	191	234
AUS	5.9241	1.2329	192	202
FIJ	0.3307	0.0632	302	317
REU	2.6683	2.3329	181	196
RNE	0.1398	4.8179	242	257
RAF	0.5422	0.9399	285	300
RCA	0.0759	0.0359	172	187
RSA	0.1768	2.6065	248	263
REA	0.092	1.0198	246	261
RSO	1.1481	2.3093	246	261

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex X: Results of the Full Liberalization Scenario under the Second Sensitivity Analysis (ε*2)

	Supply mill MT	Demand mill MT	Producer Price €/ ton	Consumer Price €/ ton
AT	0.1253		298	
BE	0.1773		298	
CZ	0.2472		298	
DK			299	
ES			302	
FI	0.0203		298	
FR	1.2676		298	
GE	0.988		298	
GR			350	
HU	0.1763		298	
IE				
IT			337	
LT	0.0231		298	
LV				
NL	0.2506		298	
PL	0.5679		298	
PT			330	
SI				
SK	0.0412		298	
SW	0.2574		298	
UK	0.6538		298	
ALB	0.004	0.0928	303	318
BOS		0.1403		388
BUL	0.0015	0.2868	305	320
EUR	4.7958	19.1718		308
NOR		0.1949		310
ROM	0.0193	0.6244	305	320
RUS	2.0644	6.1399	304	319
SER	0.3592	0.3592	337	352
SWI		0.5109	373	308
TUR		2.3124	503	320
ALG		1.2268		316
BEN	0.0026	0.0383	298	313
BUR	0.0414	0.073	367	382
CDR	0.0667	0.0955	299	314
CON	0.0548	0.0646	298	313
COT	0.1414	0.2359	297	312
EGY	1.8306	2.7931	303	318
ETH	0.3616	0.3024	297	312
GAB	0.0218	0.0225	299	314
GUI	0.0272	0.1205	297	312
KEN	0.4196	0.8129	303	318
MAD	0.0258	0.1443	302	317
MAL	0.2771	0.1572	223	238
MAU	0.3012	0.0462	245	260
MLI	0.0355	0.1031	367	382
MOR	0.3594	1.3482	301	316
MOZ	0.2484	0.1576	244	259
NIG	0.0101	1.2589	298	313
SAC		0.2376		262
SAF	3.0455	1.6757	241	256
SEN	0.0957	0.1914	297	312
SRL	0.006	0.0259	297	312
SUD	0.7887	0.83	309	324
SWA	0.9364	0.0248	171	186
TAN	0.1876	0.4926	299	314
TOG		0.0558		313

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex X continued: Results of the Full Liberalization Scenario under the Second Sensitivity Analysis

	Supply mill MT	Demand mill MT	Producer Price €/ ton	Consumer Price €/ ton
UGA	0.1648	0.2296	373	388
ZAM	0.3072	0.1182	223	238
ZIM	0.4537	0.3246	174	189
BAR	0.0186	0.0186	240	255
BEL	0.1093	0.0128	239	254
CAN	0.1315	1.412	296	306
COR	0.5001	0.2518	238	253
CUB	1.2954	0.6609	237	252
DOM	0.4741	0.3561	238	253
ELS	0.7159	0.2383	234	249
GUA	2.3959	0.7165	234	249
HAI		0.1992		311
HON	0.4678	0.2693	239	254
JAM	0.1142	0.1303	296	311
MEX	4.315	5.9527	298	313
NIC	0.5813	0.2066	235	250
PAN	0.1261	0.1306	292	307
STK	0.0135	0.0055	237	252
TRI	0.0195	0.0749	294	309
UB	0.6282		296	
UC	2.0544		296	
USA		8.9087		306
ARG	2.7741	1.7281	231	246
BOL	0.3849	0.272	218	233
BRA	49.4172	11.0721	232	247
CHL	0.5432	0.7513	294	309
COL	3.6413	1.7217	233	248
ECU	0.5083	0.4812	236	251
GUY	0.2728	0.0247	236	251
PAR	0.1146	0.1477	294	309
PER	0.9922	0.9922	287	302
SUR	0.0048	0.0234	293	308
URU	0.009	0.1191	287	302
VEN	0.6915	0.9493	294	309
BAN	0.1317	1.1024	307	322
CHN	10.1994	11.9394	302	317
IND	18.898	22.6167	309	324
INS	2.4251	4.1802	302	317
IRN	1.4049	2.2439	312	327
JAP		2.4098	674	311
MLY	0.077	1.2583	303	318
NEP	0.1383	0.1383	369	384
PAK	3.78	4.8395	309	324
PNG	0.0564	0.0364	241	256
PHI	2.2811	2.2811	300	315
SOK		1.2149		318
THA	7.7123	2.4443	247	262
AUS	8.1288	1.1944	248	258
FIJ	0.2856	0.0647	239	254
REU	3.875	2.2372	241	256
RNE	0.1623	4.7416	303	318
RAF	0.5614	0.9364	300	315
RCA	0.0941	0.0348	239	254
RSA	0.2029	2.5501	309	324
REA	0.1046	0.9992	302	317
RSO	1.3052	2.2626	302	317

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex XI: Results of the Baseline Scenario under the Third Sensitivity Analysis (ε*½)

	Supply mill MT	Demand mill MT	Producer Price €/ ton	Consumer Price €/ ton
AT	0.3873		365	
BE	0.8198		362	
CZ	0.4549		365	
DK	0.4207		386	
ES	0.835		431	
FI	0.117		431	
FR	4.0325		365	
GE	3.6555		360	
GR	0.1741		431	
HU	0.4017		370	
IE			702	
IT	0.7787		423	
LT	0.103		404	
LV			702	
NL	0.8646		369	
PL	1.6719		359	
PT	0.0445		427	
SI			702	
SK	0.1999		431	
SW	0.3257		321	
UK	1.1386		345	
ALB	0.0033	0.093	292	307
BOS		0.1404		384
BUL	0.003	0.2796	434	449
EUR	16.4254	18.5764		441
NOR		0.1865		410
ROM	0.046	0.6087	434	449
RUS	2.4507	6.0672	359	374
SER	0.3693	0.361	314	329
SWI	0.2023	0.4516	525	677
TUR	2.1621	2.1621	611	626
ALG		1.2364		292
BEN	0.0039	0.0381	357	327
BUR	0.0402	0.0726	386	401
CDR	0.0639	0.095	355	328
CON	0.0549	0.0639	337	352
COT	0.1343	0.2349	310	325
EGY	1.651	2.8027	292	307
ETH	0.337	0.3036	356	299
GAB	0.022	0.0222	356	353
GUI	0.0265	0.12	358	325
KEN	0.5566	0.7713	522	537
MAD	0.025	0.1437	352	331
MAL	0.2505	0.1538	281	296
MAU	0.5091	0.0448	343	358
MLI	0.0345	0.1026	386	401
MOR	0.4946	1.3273	498	513
MOZ	0.2611	0.1524	351	362
NIG	0.0111	1.2277	387	402
SAC		0.2245		556
SAF	2.4745	1.5505	205	556
SEN	0.0931	0.1906	359	325
SRL	0.0059	0.0258	358	325
SUD	0.8028	0.8183	358	373
SWA	0.681	0.022	135	627
TAN	0.2506	0.4668	522	537
TOG		0.0556		327

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex XI continued: Results of the Baseline Scenario under the Third Sensitivity Analysis

	Supply mill MT	Demand mill MT	Producer Price €/ ton	Consumer Price €/ ton
UGA	0.1898	0.2226	515	530
ZAM	0.2777	0.1157	281	296
ZIM	0.4668	0.3167	226	241
BAR	0.0329	0.0179	381	373
BEL	0.1144	0.0125	297	312
CAN	0.1026	1.4176	271	281
COR	0.4019	0.2561	198	213
CUB	1.7582	0.6723	197	212
DOM	0.5028	0.349	294	309
ELS	0.584	0.2419	199	214
GUA	1.9243	0.7286	195	210
HAI		0.1958		370
HON	0.3738	0.274	198	213
JAM	0.1433	0.128	355	370
MEX	5.6765	5.6765	488	503
NIC	0.471	0.2098	198	213
PAN	0.158	0.1289	336	351
STK	0.0196	0.0053	356	371
TRI	0.0303	0.0735	380	373
UB	3.8379		391	
UC	3.2236		339	
USA		8.7858		414
ARG	2.2539	1.7551	195	210
BOL	0.3317	0.2751	193	208
BRA	30.7934	11.2337	195	210
CHL	0.4136	0.7387	269	366
COL	2.9189	1.7517	193	208
ECU	0.4876	0.4787	249	264
GUY	0.29	0.0245	300	273
PAR	0.1172	0.1462	328	343
PER	0.8433	1.0043	252	267
SUR	0.005	0.023	357	372
URU	0.0079	0.1201	263	278
VEN	0.6334	0.9502	291	306
BAN	0.131	1.0911	350	357
CHN	9.8981	11.8642	322	337
IND	21.8901	21.8901	431	449
INS	2.3487	4.1539	322	337
IRN	1.3445	2.2338	327	342
JAP	1.1197	2.1882	1063	1073
MLY	0.0723	1.2601	298	313
NEP	0.1319	0.1381	376	391
PAK	3.7996	4.7805	351	366
PNG	0.0472	0.0368	209	224
PHI	2.3831	2.2695	317	332
SOK		1.2296		294
THA	6.5024	2.4434	215	263
AUS	5.7812	1.2146	217	227
FIJ	0.301	0.0655	207	222
REU	2.5805	2.29	205	220
RNE	0.1378	4.785	266	281
RAF	0.5331	0.9333	314	329
RCA	0.0748	0.0354	196	211
RSA	0.1741	2.5822	272	287
REA	0.091	1.0102	270	285
RSO	1.1329	2.2875	270	285

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex XII: Results of the Full Liberalization Scenario under the Third Sensitivity Analysis (ε*½)

	Supply mill MT	Demand mill MT	Producer Price €/ ton	Consumer Price €/ ton
AT	0.3529		358	
BE	0.7434		358	
CZ	0.4282		358	
DK	0.282		358	
ES	0.3895		358	
FI	0.0659		358	
FR	3.6277		358	
GE	3.4013		358	
GR	0.0179		358	
HU	0.3603		358	
IE			358	
IT	0.1943		358	
LT	0.07		358	
LV			358	
NL	0.74		358	
PL	1.6197		358	
PT	0.0136		358	
SI			358	
SK	0.1179		358	
SW	0.4031		358	
UK	1.2017		358	
ALB	0.0035	0.0916	362	377
BOS		0.1388		447
BUL	0.0022	0.2831	364	379
EUR	14.0293	18.8761		368
NOR		0.1896		370
ROM	0.0321	0.6165	364	379
RUS	2.4612	6.0615	363	378
SER	0.3849	0.3578	356	371
SWI		0.4969	373	368
TUR		2.2733	503	379
ALG		1.2058		375
BEN	0.0039	0.0376	357	372
BUR	0.0409	0.0719	426	441
CDR	0.064	0.0938	358	373
CON	0.0554	0.0635	357	372
COT	0.1374	0.2318	356	371
EGY	1.7114	2.7455	362	377
ETH	0.3371	0.2971	356	371
GAB	0.022	0.0221	358	373
GUI	0.0265	0.1184	356	371
KEN	0.5237	0.7991	362	377
MAD	0.0252	0.1418	361	376
MAL	0.2508	0.1537	282	297
MAU	0.499	0.0453	304	319
MLI	0.0351	0.1017	426	441
MOR	0.4686	1.3251	360	375
MOZ	0.2548	0.1543	303	318
NIG	0.011	1.2371	357	372
SAC		0.234		321
SAF	2.636	1.641	300	315
SEN	0.093	0.1881	356	371
SRL	0.0059	0.0254	356	371
SUD	0.8066	0.8161	368	383
SWA	0.7439	0.0241	230	245
TAN	0.2353	0.4841	358	373
TOG		0.0549		372

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex XII continued: Results of the Full Liberalization Scenario under the Third Sensitivity Analysis

	Supply mill MT	Demand mill MT	Producer Price €/ ton	Consumer Price €/ ton
UGA	0.1843	0.2264	432	447
ZAM	0.278	0.1156	282	297
ZIM	0.4693	0.3158	233	248
BAR	0.0316	0.0183	296	311
BEL	0.1145	0.0125	298	313
CAN	0.1118	1.4005	356	366
COR	0.4293	0.2465	297	312
CUB	1.6925	0.6473	295	310
DOM	0.5036	0.3487	297	312
ELS	0.6222	0.2332	294	309
GUA	2.056	0.7013	293	308
HAI		0.1958		369
HON	0.3995	0.2637	298	313
JAM	0.1393	0.1302	298	313
MEX	5.3929	5.8514	356	371
NIC	0.5023	0.2022	294	309
PAN	0.1549	0.1304	297	312
STK	0.019	0.0054	296	311
TRI	0.0299	0.0736	353	368
UB	2.735		356	
UC	3.2816		356	
USA		8.8362		366
ARG	2.4041	1.691	290	305
BOL	0.3519	0.2659	277	292
BRA	35.5671	10.8564	291	306
CHL	0.452	0.7382	353	368
COL	3.1221	1.685	292	307
ECU	0.5012	0.4711	295	310
GUY	0.2893	0.0242	295	310
PAR	0.1186	0.1451	353	368
PER	0.89	0.9732	351	366
SUR	0.005	0.023	352	367
URU	0.0083	0.117	346	361
VEN	0.6537	0.9327	353	368
BAN	0.1322	1.0827	370	385
CHN	10.0935	11.7231	365	380
IND	21.3551	22.238	368	383
INS	2.3951	4.1044	365	380
IRN	1.3715	2.2067	371	386
JAP		2.3752	674	375
MLY	0.0746	1.2356	366	381
NEP	0.1352	0.1361	438	453
PAK	3.8283	4.7585	368	383
PNG	0.0501	0.0356	304	319
PHI	2.373	2.2754	308	323
SOK		1.1806		381
THA	6.8846	2.3892	310	325
AUS	6.4695	1.1607	312	322
FIJ	0.3193	0.0632	302	317
REU	2.9206	2.1648	300	315
RNE	0.145	4.6809	362	377
RAF	0.5452	0.9244	359	374
RCA	0.0801	0.0341	298	313
RSA	0.1825	2.5053	368	383
REA	0.0953	0.9802	365	380
RSO	1.1875	2.2196	365	380

Source: Own Simulations; All quantities are expressed in million metric tons WSE.

Annex XIII: Regression Results for Ocean Freight Rates

Full Sample

Regression Statistics	
Multiple R	0.7867211
R Square	0.6189302
Adjusted R Square	0.6187940
Standard Error	8.6140763
Observations	11197

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	1348845.5	337211.4	4544.5	0
Residual	11192	830472.3	74.2		
Total	11196	2179317.7			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Schnittpunkt	2.34071	0.36632	6.38985	0.00000	1.62267	3.05876
BDI	0.00598	0.00008	78.29510	0.00000	0.00583	0.00613
Distance	0.00301	0.00003	98.41417	0.00000	0.00295	0.00307
PANAMA	1.49369	0.18202	8.20601	0.00000	1.13689	1.85049
SUEZ	5.27049	0.24481	21.52853	0.00000	4.79061	5.75037

Sources: ISO (various years); own calculations.
All Coefficients in Annex XIII refer to ocean freight rates for raw sugar in US$ per ton.

Annex XIII continued: Regression Results for Exporting Regions

	Cuba			Northern Brazil			Santos		
Constant	-4.613053684	***	(1.4892)	-2.818142722	***	(0.6872)	-7.679694947	***	(0.7684)
BDI	0.008313834	***	(0.0003)	0.007086638	***	(0.0002)	0.007269771	***	(0.0002)
Distance	0.002944772	***	(0.0002)	0.003363236	***	(0.0001)	0.003719908	***	(0.0001)
Panama	7.637006269	***	(1.3198)	-		-	-		-
Suez	17.28445651	***	(1.2789)	15.14819084	***	(0.5394)	15.89365308	***	(0.5489)
R^2			0.7852029			0.817657173			0.7960275
F Test			793.25585			2654.63169			2310.3523
			(0.0000)			(0.0000)			(0.0000)
Number of Observations			873			1,780			1,780

	Puerto Quetzal (GUA)			Buenaventura (COL)			Thailand		
Constant	-0.873130823		(0.8419)	-2.415953967	**	(1.1520)	10.82876814	***	(0.5790)
BDI	0.006210648	***	(0.0001)	0.006034012	***	(0.0001)	0.003434191	***	(0.0001)
Distance	0.003688335	***	(0.0001)	0.003659923	***	(0.0001)	0.002143591	***	(0.0000)
Panama	-		-	4.994579041	***	(0.5289)	-		-
Suez	4.814028017	***	(0.6377)	5.527554454	***	(0.7322)	-		-
R^2			0.716339			0.725072074			0.6899523
F Test			1494.998			1170.309386			1977.188
			(0.0000)			(0.0000)			(0.0000)
Number of Observations			1,780			1,780			1,780

	Durban (SAF)		
Constant	23.26103336	***	(0.8092)
BDI	0.004053154	***	(0.0001)
Distance	0.000748388	***	(0.0001)
Panama	-		-
Suez	1.047327445	**	(0.4483)
R^2			0.39495 82
F Test			308.981 73
			(0.0000)
Number of Observations			1,424

Sources: ISO (various years); own calculations.
* significant at the 0.1 level, ** significant at the 0.05 level, *** significant at the 0.01 level.

Annex XIII continued: Regression Results for Importing Regions

	Venezuela			U.S. Gulf			Baltic		
Constant	10.93245146	***	(0.6700)	16.01600551	***	(0.6858)	13.54573358	***	(2.1727)
BDI	0.004050043	***	(0.0002)	0.00449259	***	(0.0002)	0.007111354	***	(0.0001)
Distance	0.001548332	***	(0.0000)	0.001160372	***	(0.0000)	0.000360337		(0.0004)
Panama	-		-	0.601210262	*	(0.3247)	6.297487275	***	(0.4043)
Suez	-		-	-		-	0.744451836		(1.6288)
R^2			0.6261622			0.587782713			0.7282933
F Test			824.07894			505.7209926			658.04781
			(0.0000)			(0.0000)			(0.0000)
Number of Observations			987			1,068			987

	Morocco			Egypt			Black Sea		
Constant	14.08799525	***	(0.8550)	10.38770027	***	(1.8006)	9.814111429	***	(1.9994)
BDI	0.00571694	***	(0.0002)	0.006547164	***	(0.0002)	0.006579271	***	(0.0002)
Distance	0.000741939	***	(0.0001)	0.001283308	***	(0.0003)	0.001446148	***	(0.0003)
Panama	6.28092828	***	(0.3607)	4.840144017	***	(0.5245)	5.555598565	***	(0.5423)
Suez	-		-	-		-	0.713519983	*	(0.4173)
R^2			0.5919195			0.652341012			0.6501116
F Test			561.34219			726.1597739			538.83576
			(0.0000)			(0.0000)			(0.0000)
Number of Observations			1,165			1,165			1,165

	Southern China			Japan			South Korea		
Constant	-8.791031601	***	(0.8967)	-5.1894745	***	(1.0717)	-8.739948684	***	(0.9409)
BDI	0.006525947	***	(0.0002)	0.006213817	***	(0.0002)	0.006283173	***	(0.0002)
Distance	0.004084398	***	(0.0001)	0.004103911	***	(0.0001)	0.004134427	***	(0.0001)
Panama	1.884018491	**	(0.7422)	9.649549876	***	(0.8300)	8.355290906	***	(0.7365)
Suez	-		-	-		-	-		-
R^2			0.8283981			0.769850907			0.8145041
F Test			1868.22			1294.518684			1699.299
			(0.0000)			(0.0000)			(0.0000)
Number of Observations			1,165			1,165			1,165

	Southern China		
Constant	-8.791031601	***	(0.8967)
BDI	0.006525947	***	(0.0002)
Distance	0.004084398	***	(0.0001)
Panama	1.884018491	**	(0.7422)
Suez	-		-
R^2			0.8283981
F Test			1868.22
			(0.0000)
Number of Observations			1,165

Sources: ISO (various years); own calculations.
* significant at the 0.1 level, ** significant at the 0.05 level, *** significant at the 0.01 level.