Trade and Welfare Impacts of Partial Liberalization of U.S. Sugar TRQs:

The Application of a PE/GE Modeling Approach

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Abstract

The sugar sector is one of the most heavily protected commodities in agriculture using a system of tariff rate quotas (TRQs) with a complex set of administration procedures. General equilibrium models are not suitable to analyze trade liberalization scenarios that involve numerous tariff-rate quotas across narrowly defined product lines. We use the Rutherford/Grant/Hertel modeling approach by embedding a detailed, partial equilibrium (PE) model into a standard, global general equilibrium (GE) framework. We use this PE/GE model to compare trade and welfare outcomes of two liberalization scenarios: Increasing quota levels by 25% and cutting over tariffs by 50%, versus increasing quota levels by 50% and cutting over-quota tariffs by 25%. We find that lowering over-quota tariffs relatively more has more positive welfare effects than increasing quota levels relatively more.

Introduction

For 60 years agricultural trade policies have increased in complexity, making the analysis of trade liberalization a formidable task for policy makers. The international sugar sector is no exception. This sector includes some of the most heavily protected commodities in agriculture. The Uruguay Round (UR) of multilateral trade negotiations brought agriculture under the disciplines of the GATT in 1994 and required WTO members to convert non-tariff barriers into tariffs through a process known as tariffication. Many developed countries had to convert their non-tariff barriers into systems of tariff rate quotas (TRQs) with a complex set of administration procedures. For this reason, trade liberalization results from general equilibrium analyses involving numerous tariff-rate quotas across narrowly defined product lines run into major difficulties that limit the scope and accuracy of their results (Grant, Hertel and Rutherford 2008; Bureau and Salvatici, 2003).

To bring further reform to agricultural trade, WTO members initiated the Doha Development Agenda (DDA) in 2001. Although this round of negotiations intends to address reform in domestic support and export competition, market access has been a key focus in the negotiations. In addition to reducing tariffs, two central market access issues being debated in the on-going though currently dormant Doha Round of WTO negotiations are the option to allow a percentage of total agricultural tariff lines to be considered as *sensitive* and, only for the developing countries, the option to declare a share of tariff lines as *special* (WTO, 2008). The sensitive and special lines are intended to undergo lower or no cuts from the current bound levels. Products subject to TRQs in a country's tariff schedule are generally considered those most politically sensitive and/or economically vulnerable to tariff cuts. It is therefore reasonable to assume that these products, such as sugar, will fall under either the *sensitive* or the *special* category.

Under the July 2008 Chairman's text (WTO, 2008), developed countries would be allowed to declare between 4-6 percent of their total tariff lines as being sensitive. The products declared to be sensitive would incur lower tariff cuts (1/3 to 2/3 of formula cut) and be required to provide additional market access under a TRQ (3-6 percent of domestic consumption). If the United States were to declare sugar to be sensitive, the current size of the TRQ would have to be expanded, while sugar tariffs would undergo a smaller cut than the agreed upon formula cut.

Since TRQs are established at a disaggregated tariff-line level, any analysis that uses tariffs at the aggregated level will fail to accurately capture the potential impacts from the suggested reform modalities.

Computable general equilibrium (CGE) models, such as the Global Trade Analysis Project (GTAP) model, are one of the most commonly used tools in analyses of DDA market access reform scenarios. However, to remain tractable these models typically require considerable aggregation across product lines, across different policy instruments, and across regions. This aggregation tends to obscure the heterogeneity in protection instruments, including tariff rate variations across tariff lines as well as difference between over- and in-quota rates. To address these concerns, Grant, Hertel, and Rutherford (2006) extended general equilibrium analysis to the "tariff line" by embedding a detailed, partial equilibrium (PE) model into a standard, global general equilibrium (GE) framework and this combination we call a PE/GE model. In their first PE/GE approach they chose the global dairy sector, which is also characterized by numerous tariff line level specifications. Utilizing a mixed-complementarity formulation they were able to more accurately represent the workings of bilateral and multilateral dairy trade policy. Their analysis examined the impact of liberalizing U.S. dairy imports via expansion of bilateral and multilateral tariff rate quotas, as well as reductions in out-of-quota tariffs.

In this study, we adopt the PE/GE approach of Grant, Hertel and Rutherford (2006) to investigate the trade and welfare implications of liberalizing U.S. raw sugar market access policy. Previous studies have focused on raw sugar TRQs using the GTAP model (Elbehri *et al*. 2004; van der Messenbrugghe, Beghin and Mitchell 2003). This study adopts a mixed-complementarity framework similar to these studies. However, what distinguishes this study from theirs and many others is: (a) the level of disaggregation embedded in the sub-sector (PE) model thereby allowing for an explicit evaluation of trade policy at the "tariff line" (the PE/GE approach); and (b) the treatment of bilateral trade to incorporate country-designated TRQ allocations between the U.S. and its major sugar suppliers.

We continue by providing information on the sugar sector and U.S. sugar trade policy. We will then describe the model before we review the economics of tariff quotas. Two trade liberalization scenarios and their possible results will be presented before we conclude.

Sugar—a widely traded and protected agricultural commodity

Sugar—beet sugar or cane sugar—is produced in over 140 countries and more than 100 countries produce sugar cane. World production for the 2007/08-2009/10 average exceeded 150 million metric tons (MT), raw value, of which about one-third or 50 million MT were traded. Brazil is by far the largest producer, with about 33 million MT, two-thirds of which were exported. Other important producers and traders are India, the EU, China, and Thailand, which in 2007/08-2009/10 exported 5.4 million MT of a 7 million MT production. The U.S. produced about 7 million MT during that period and imported close to 2.5 million MT.

U.S. sugar import policy

The United States is the fourth largest importer of sugar and sugar containing products (Haley and Ali 2007). In 2005/2006, the U.S. imported more than 3.1 million metric tons of raw and refined sugar (raw value), accounting for 7 percent of world trade. In 2009/2010, the imported amount was 2.2 million tons. Almost all raw sugar and other sugar containing products are regulated by TRQs. (The minimum TRQ for raw cane sugar is 1,117,195 metric tons and the minimum TRQ for refined sugar is 22,000 metric tons ,USDA/FAS, 2007). Tariff rate quotas or TRQs are a two-tiered tariff system, whereby within a set quota a lower in-quota tariff is levied on imports, while imports exceeding the set quota amount are charged a higher over-quota tariff rate. Thus, the U.S. (and many other countries) has implemented a complex web of TRQ administrative procedures, which in addition to the high tariff rates can discourage trade. Quota administration can present special challenges in policy analysis because the estimated social welfare can vary depending on who gets the right to supply imports at the favorable in-quota tariff rate.

The U.S. in-quota tariff for sugar is equal to 0.625 cents per pound. Most countries have the in-quota tariff waived under either the Generalized System of Preferences (GSP), the Caribbean Basin Initiative, or under other U.S. free trade agreements (Haley and Ali, 2007). The over-quota tariff is 15.36 cents per pound for raw sugar and 16.21 cents per pound for refined sugar (ERS, 2009), which is high enough to constitute a de facto prohibitive tariff rate. Based on the formula agreed upon by WTO members (WTO 2005), ad valorem conversions of U.S. most favored nation (MFN) sugar tariffs are presented in table 1. As evident from this table, for a given import value, whether in-quota or over-quota tariff is levied can make a significant difference. As mentioned, tariff rates can further vary across exporting countries based on their special trade arrangements with the U.S. government. Therefore, bilateral import tariffs are used in this analysis rather than the MFN tariffs presented in table 1.

Sugar quotas and fill ratios

Also as illustrated in table 1, the U.S. establishes separate TRQs for imports of sugar and imports of sugar containing (processed) products such as syrups, molasses and other processed food. Raw sugar is imported via country-designated licenses to 40 countries, which are announced each year (table 2 presents allocations for 2003-2007 and table 3 presents them for 2008). The allocation of export licenses is based on U.S. imports during 1975-1981, a period when trade was relatively unrestricted (Haley and Ali, 2007). Because this quota is granted to specific suppliers and may only be filled with the suppliers' own sugar production, it is called a supplier tariff-rate quota (Skully, 1998). For refined sugar and other sugar containing products a single quota exists and is available on a first-come-first-served basis.

The largest quotas are assigned to Brazil, the Dominican Republic, and the Philippines, with TRQs between 142,000 and 185,000 MT in 2009 followed by Australia and Guatemala with 87,000 and 51,000 MT each. Together these five countries account for over 55 percent of the total allocation of raw sugar quotas. In addition to the 40 countries that are entitled to supply raw sugar under a quota allocation, sugar is supplied by Mexico who as members of the North America Free Trade Agreement (NAFTA) are facing no import restrictions. Not all countries will indeed fill their quotas. Between 2006 and 2009, between 23 and 48 percent of the countries with TRQ allocations under the WTO did not ship any sugar (or less than 3 percent of the permitted amount) to the U.S. The willingness to supply the U.S. with sugar is linked to the price of sugar with respect to transportation costs. The world sugar price is typically around 6 cent per lb below the U.S. sugar price. However, the gap can be as large as 15 cents (as is the case in early 2010). If the world price is high as well as transportation costs, suppliers may decide to sell their sugar closer to home. This has been true for several sub-Saharan African countries such as Congo, Côte d'Ivoire, Gabon, and Madagascar. Several Caribbean countries such as Barbados, Haiti, and Trinidad-Tobago have also failed to fulfill their quota in recent years. Of the 40 countries with TRQ allocations[1] only 40 percent filled their entire quota[2] in 2009, down from 70 percent in 2006, when sugar prices were lower.

The concept of fill rate with respect to allocated quota is an important one as trade liberalization scenarios are based on the assumption that suppliers are interested in exporting more sugar to the U.S. in the case of increased quota allocations or lower over-quota tariffs. The most cost efficient producers do fulfill their quotas and are likely suppliers of sugar in the event that their access to the U.S. market increases. We use fill ratios to identify the particular regime an exporters faces: (i) within-quota shipments for countries that ship raw sugar cane, but do not fulfill their quota (regime 1 or line 2 in figure 4); (ii) at the quota limit shipments for those countries that fulfill their quota completely, but do not ship at the over-quota tariff rate (regime 2 or line 3 in figure 4); and over-quota shipments (regime 3 or line 4 in figure 4).

The model: concept and implementation

This section describes the concept and implementation of a partial equilibrium (PE) model of world sugar and confectionary trade at the 6-digit level of the Harmonized Commodity Description and Coding System (HS) that is nested in a standard general equilibrium (GE) model. Import policy is generally defined at the tariff line[3]. Yet most analyses of trade liberalization are conducted at a much more aggregated level. Computable General Equilibrium (CGE) models are universally susceptible to the problem of policy aggregation, i.e., being incapable of capturing the dynamics of a particular market because policies affecting specific commodities cannot be adequately accounted for. Moreover, these models become increasingly irrelevant as policy negotiations intensify into sensitive sectors—individual commodities of great importance to a particular country. At this level of detail, countries employ a mix of standard and

[1] Mexico is a special case of a country that has a TRQ allocation as part of the WTO allocations despite the fact that the NAFTA agreement gives Mexico free access to the U.S. market as of January 2008.
[2] These countries mostly filled their quota to 100%, but at least above 95%.
[3] Export subsidies and domestic support are usually defined at a higher level of aggregation.

nonstandard policies such as tariff rate quotas (TRQs) geared toward a particular commodity identified at a 6-, 8-, or even 10-digit level of the harmonized system (HS), which are not well represented in current GE analyses.

The model: an overview

The sub-sector (PE) sugar and confectionary model is formulated as a mixed-complementarity program (MCP) and subsequently embedded in a slightly modified GTAP-in-GAMS (GE) model (Rutherford 2005). The sub-sector products (34 of them) are essentially treated as additional GTAP sectors in the PE/GE model. Figure 3 provides a conceptual framework of the sub-sector sugar and confectionary model using the U.S. as the importing country and the Caribbean and Australia as representative exporting countries. Sub-sector sugar products are produced using a constant elasticity of transformation (CET) function in each region that permits sugar capacity to be shifted between all 34 HS6 products (e.g. raw sugar and crisp-bread or chewing gum). Indeed, this multi-product industry potentially produces all 34 HS6 sugar related products. Sugar output is then shipped to the domestic market or exported abroad. In this simplified example we only look at those exports destined to the United States.

After sub-sector products are exported to the U.S. market they are consumed at the HS6 level where they substitute in a constant elasticity of substitution (CES) function. Higher prices encourage more production (via the transformation function) and less consumption (via the substitution function). Similar to the standard GTAP model, sugar and confectionary products in the sub-sector model are differentiated by country of origin in the manner pioneered by Armington (1969). Products from different sources are substitutable and this substitutability is governed by the import-import elasticity of substitution (σ^{MM}). Imports from different sources are then aggregated into a composite import before substituting for domestic output. In this CES nest composite imports substitute with domestic output based on the import-domestic elasticity of substitution (σ^{DM}). Finally, domestic output and composite imports are combined in a higher level CES nest where U.S. expenditure takes place.

The MCP formulation of the quota model

Given the importance of sugar and confectionary products in U.S. imports we introduce several bilateral TRQ policies for this tariff line. Tariff-quota activities are based on the following market clearing condition:

$$(1) \qquad X^{IQ}_{g,r,s} + X^{OQ}_{g,r,s} = X^{EX}_{g,r,s}\left(\frac{P^{M}_{g,r}}{P^{X}_{g,r,s}}\right)^{\sigma_M}$$

where exports of sugar products (*g*) ($X^{IQ}_{g,r,s}$ and $X^{OQ}_{g,r,s}$) can be delivered as in-quota trade ($X^{IQ}_{g,r,s}$) facing an in-quota tariff rate (t^{in}) and quota rent ((P2-P1)*Q in figure 4) in the case of regime 2, or as out-of-quota trade ($X^{OQ}_{g,r,s}$) facing a much higher tariff rate (t^{out}). Note that in an MCP formulation, equation (1) determines the equilibrium product price ($P^{X}_{g,r,s}$) in the destination (U.S.) market, inclusive of the in (t^{in}) or out-of quota (t^{out}) tariff rates and any quota rent all of which are source (*r*) and destination (*s*) specific.

Equilibrium in tariff-quota trade implies zero profits on exports, after appropriate distribution of quota rents, so the sub-sector quota model is augmented with a zero-profit constraint for each tariff quota activity. Following the MCP convention (Rutherford 1995; vdM-B-M 2003), the zero-profit condition for in-quota trade (X^{IQ}) is:

$$(2) \qquad X^{IQ}_{g,r,s} \geq 0 \quad \perp \; P^{X}_{g,r,s} - P^{Y}_{g,r} T^{in}_{g,r,s} - q^{rent}_{g,r} \leq 0$$

where, $T^{in}_{g,r,s}$ denotes the power (1 + rate) of the in-quota trade cost, including taxes/subsidies and transport margins between *r* and *s*. In the zero-profit condition (2), $X^{IQ}_{g,r,s} \geq 0$ holds with strict *inequality* if $P^{X}_{g,r,s} \leq P^{Y}_{g,r} T^{in}_{g,r,s} + q^{rent}_{g,r}$ holds with strict *equality*. For regime 2 (pure quota regime) to be operating, quota rents ($q^{rent}_{g,r}$) precisely exhaust the difference between the domestic supply price of raw sugar in the source region ($P^{Y}_{g,r}$) and the tariff-inclusive import price ($P^{X}_{g,r,s}$) if in-quota imports hit the quota level. The variable $q^{rent}_{g,r}$, is a slack variable that takes on value once $X^{IQ}_{g,r,s}$ hits the quota level denoted $X^{UP}_{g,r,s}$ which one will note is country specific:

$$(3) \qquad q^{rent}_{g,r} \geq 0 \quad \perp \; X^{IQ}_{g,r,s} \leq X^{UP}_{g,r,s}$$

where $q^{rent}_{g,r} > 0$ can only occur if $X^{IQ}_{g,r,s} \leq X^{UP}_{g,r,s}$ holds with strict equality. Quota rents are assumed to accrue to the source region *r*.

Analogously, the zero-profit condition for out-of-quota trade is:

(4) $X^{OQ}_{g,r,s} \geq 0 \quad \perp P^{X}_{g,r,s}\text{-}P^{Y}_{g,r}T^{out}_{g,r,s} \leq 0$

where positive out-of-quota trade $X^{OQ}_{g,r,s} > 0$ implies that $P^{X}_{g,r,s} \leq P^{Y}_{g,r}T^{out}_{g,r,s}$ must hold with strict equality. Note there are no quota rents on out-of-quota imports.

Implementation

The PE sugar and confectionary model is developed from detailed information on trade and protection levels taken from the World Integrated trading System (WITS) database housed by the World Bank. The model is then nested in the standard GTAP7 in GAMS model developed by Thomas Rutherford. The base year of the PE data are averages of 2004-2006, while the GTAP (GE) component of the model is based on the year 2004. The model is customized by selecting sectors and countries or regional country groups of interest in the sugar sector. Trade and protection data were obtained from the WITS database, quota allocations and actual sugar shipments were obtained from the United States Trade Representative (USTR) and fill ratios of allocated quotas were calculated.

Sectors--The product selection for the PE model depends on the GTAP model sectors since the PE and GTAP (GE) models will be linked and must be reconciled in the calibration process. For the sugar and confectionary model, we selected all tariff lines that fall under GTAP's sugar (SGR) sector which comprises seven HS6 tariff lines. In addition, we also selected several confectionary products in more processed form. These lines fall under GTAP's other food sector (OFD). However, 290 HS6 tariff lines map into GTAP's OFD sector. To make the PE model more tractable in the number of product lines, we disaggregated the 26 HS6 product lines that are part of confectionary products under other food (OFD) and aggregated the remaining 264 into an aggregate HS code called "all other OFD lines (ofdo)". In total we have 33 HS6 disaggregated sugar related product lines plus the aggregate "other food" sector in the PE comprising the SGR and OFD sectors of GTAP. Table 4 describes these 34 product lines.

Countries and country groups--Based on the relative importance of sugar (SGR) and other food (OFD) imports and exports, table 5 lists the country aggregations that are used in the model—10 individual countries and 8 regional aggregates. These 18 countries/groups account for all 113 countries in GTAP. Figure 1 graphs total imports and exports of all 34 sugar and confectionary products for each of the eighteen PE/GE model regions. During our base period 2004-2006, EU25 members were the largest player in this market in terms of both imports and exports with imports totaling over $66 billion dollars and exports totaling over $71 billion. EU exports have since declined considerably and are only 42 percent of EU imports in 2009/10. Rest of Asia (RAS), the United States (USA) and other Europe and Central Asia (ECA) followed the EU25 member region by a large margin during our base period.

An important component of the PE/GE model is that it can accurately represent the workings of tariff-rate quotas. In the model we include bilateral quotas for one tariff line in the U.S. (raw sugar cane = rawc or HS170111). Figures 2a and 2b graph the important export suppliers of raw sugar to the U.S. market. Figure 2a depicts the individual countries while figure 2b shows exports from regional country groups used in this analysis. Not surprisingly, other Central America and Caribbean countries (CAC) and the Rest of South American (RSA), with Argentina and Peru as the region's strongest sugar cane suppliers to the U.S., are the largest exporters to the U.S. quota constrained market for raw sugar with exports of over $140 and $70 million, respectively, in 2004-2006. The Dominican Republic is the largest exporter of raw sugar to the U.S., accounting for almost 15 percent of the export market share from all sources. The Dominican Republic is followed by Brazil (11.3%) and Guatemala (10%), two other Western Hemisphere low-cost sugar producers.

Although TRQs are applied to virtually all sugar and confectionary lines, we focus on TRQs applied to **raw sugar cane** as this sector has detailed data on the method of TRQ administration (supplier quotas) and the quota levels allocated to each country. A unit problem arises because the PE/GE model data are in value terms whereas the quota information is in quantity units. We therefore use fill ratios to identify the particular regime an exporters faces: (i) within-quota shipments (regime 1); (ii) at-the-quota-limit shipments (regime 2); and over-quota shipments (regime 3). These fill ratios and the associated in- and over-quota tariff rates are reported in Table 6.

Perhaps not surprisingly, no country exceeds their country-designated quota allocation. For several countries, however, the quota is 'nearly' binding – a situation captured by regime 2. The calculated fill ratios for Australia, Brazil, Guatemala, India, and South Africa are 99 percent and several other countries have fill ratios over 96 percent. We follow *Centre d'Etudes Prospectives et d'Informations Internationales* (CEPII) and assume that fill ratios greater than 90 percent constitute a binding quota. Clearly, with this assumption in mind, 10 out of the 13 countries/regions shipping raw sugar cane and facing a TRQ in the U.S. market have a lot at stake when it comes to liberalizing U.S. raw sugar TRQs.

Model calibration

Model calibration requires that we ensure consistency of the sub-sector data with the GE model, which cannot be taken for granted since PE data and GE data come from different sources. Data reconciliation between the two model components is required for trade data and also for taxes and revenue or quota rents from TRQs. Furthermore, domestic demand and supply for the PE model need to be imputed as this kind of data is typically not available at the HS6-digit level. We use a nonlinear optimization procedure which recovers domestic demand information from each country's import intensity targets. Parameters such as elasticities were either estimated econometrically or they reflect sector specific assumptions. The elasticity of transformation governs the ease with which countries can transform their sectoral SGR or OFD output into one of the 34 HS6-digit products described in Section I (see also table 1). Because most HS6-digit SGR products share the same basic input (raw sugar) we believe this transformation elasticity is quite large and therefore set it equal to 8.0, in absolute value. The elasticity of substitution in final consumption (σ^{C}) refers to the responsiveness of final consumers in choosing between HS6-digit sugar (SGR) and other food (OFD) products. While this elasticity is surely larger than that between SGR products and other sectors, such as cereals, at the GTAP level, we believe it is not nearly as large as the transformation elasticity on the supply side and set it equal to one. The elasticity of substitution between imports from different sources (σ^{MM}) has been econometrically estimated to be 5.4 for the GTAP model. However, in estimating this GTAP parameter the estimates are based on comparably disaggregated trade data (HS6-level), but the Armington parameter in that study was constrained to be equal for all product lines within the SGR sector. It is likely that the import-import substitution elasticity varies considerably between relatively homogeneous products such as raw sugar cane (rawc), and more differentiated products such as cereal foods prepared by swelling or roasting (cerf). Thus, while the value of the sectoral level SGR import-import elasticity remains the same as is in the GTAP model (5.4), we allow the import-import elasticity between HS6-digit SGR and OFD lines in the PE model to be twice that of the GTAP elasticity (5.4*2 = 10.8) which is the elasticity of substitution across import sources (σ^{MM}) at the HS6-digit level and *k* indexes HS6-digit products. The import-domestic elasticity of substitution (the so-called Armington elasticity) σ^{DM} is set to equal half the value of σ^{MM}, or 5.4.

Increasing access to sugar: economics of TRQs, scenarios, and results

The conventional method for handling TRQs in a trade model has been to begin with a step-like excess supply curve and assume a downward sloping excess demand curve (figure 4). The TRQ entails a lower in-quota tariff (t) levied on imports that enter the country within a set quota level (Q), and a higher tariff (T) applied on imports beyond the quota level. This can be represented as given in figure 4 which has been adapted from Skully (2001). If the excess demand curve is given by line 1 and world prices are w, no imports take place as indicated by M_1 = 0. But if the excess demand curve intersects the supply curve = P_1 (the prevailing import price in the importing country when the import quota is not binding) then the quantity imported lies between the M_1 and the quota quantity Q. This is presented in the figure with the example of line 2 and import quantity M_2. The case of a binding quota is depicted by the excess demand line 3. At this level, import demand is high enough to generate a quota rent R, and the prevailing import price for the product is now P_2. But the demand is not high enough to increase the quantity imported beyond Q because to do so would require importing products at the price of P_3 which is the sum of world price w and the over-quota tariff T. When the excess demand curve further shifts out as illustrated with line 4, importers are now willing to buy the product with the over-quota tariff at a higher price of P_3. The quantity imported is then M_4, a quantity larger than the quota Q. Quota rent is the maximum possible under a TRQ, equivalent to (P3-P1)* Q. This rent needs to be rationed, and it is the distribution of rents that determines potential winners and losers. The method of quota administration generally determines the allocation of quota rents

(Skully, 2001) and in the case of historical allocation the rents accrue to the holders of quota licences.

As evident from figure 1, depending on the position of excess demand curve 3, the size of the quota rent R can vary and subsequently the import price P_2 can also vary. Given fill ratios of close to 100 percent we assume that in this sugar analysis the majority of exporters find themselves in a situation represented by line 3. The model presented here is capable of determining the value of the tariff-quota rents on a bilateral basis. The model is furthermore capable of showing when rents disappear.

Scenarios and results

We examined various liberalization scenarios that had differing degrees of trade and welfare impacts. The two scenarios we are presenting here illustrate the varying impact of the two policy tools quota versus tariff rate. In scenario one, we cut over-quota tariffs by 25% and expand quotas by 50%. In the second scenario, we cut over-quota tariffs by 50% and expand quotas by 25%. The first scenario could be interpreted as a representation of a case in which sugar were to be declared a sensitive commodity, in which case over-quota tariffs would have to undergo relatively smaller cuts while quota levels would have to be increased relatively more.

Figure 5 below reports the welfare results in percentage changes of sugar consumption. Three important findings emerge. First, the welfare changes are larger and more significant under scenario 2 which cuts over-quota tariffs relatively more than the expansion in bilateral raw sugar quotas. This is because reductions in over-quota tariffs cut immediately into prices such that the U.S. can import raw sugar from relatively cheaper sources compared to domestic production. Expansions in quotas on the other hand (unless they are binding and force exporters to change regimes) do not affect prices. Second, changes in welfare as a percent of sugar consumption are relatively small for many countries. However, in Brazil and Guatemala the changes are large suggesting that these two countries have a lot to gain when it comes to liberalizing raw sugar quotas in the U.S.. Finally, the U.S. is expected to gain from liberalizing its sugar sector. There are positive welfare effects under both scenarios, but the welfare gain is stronger under scenario 2, the case of more drastic over-quota tariff reduction. The percentage change in welfare measured as a percentage of U.S. sugar consumption is 4%, or roughly $44 million in 2004, mainly due to the reduction in price which increases consumer welfare sufficiently.

Figure 6 graphs the output response from liberalizing U.S. raw sugar quotas according to scenarios 1 and 2. Here we report the total response of the sugar sector, and not the response of the individual HS6-tariff line (rawc). With the exception of other Central America and Caribbean countries (CAC), the output responses are much greater under scenario 2 because reducing the over-quota tariff by 50% as compared to 25% has a more immediate impact on prices. South Africa and Canada see the largest output response from liberalizing U.S. raw sugar quotas.

Finally, figure 6 plots the dollar value of U.S. imports from each source country. We have to be careful in interpreting these numbers because the large bilateral trade values between the U.S and CAC, Canada, and the EU25 dwarfs the impact in other countries. However, the bilateral trade response from TRQ liberalization is again greatest under scenario 2 which cuts over-quota tariffs more aggressively compared to scenario 1 which puts more emphasis on expanding the quota level.

Conclusion

Market access for agricultural products will continue to be an important issue during future multilateral trade negotiations. Sugar remains one of the most protected commodities and therefore exporters as well as the U.S. as one of the largest importers need to have information on likely outcomes of possible liberalization scenarios. The model presented here combines a detailed partial equilibrium sector model that incorporates trade policy defined at the tariff line with a general equilibrium model that encompasses world trade. This PE/GE approach avoids misrepresenting the trade impacts due to excessive aggregation. Of particular value in the sugar sector is the fact that our model is capable to capturing bilateral trade policy by explicitly allowing for differing quotas and tariff rates between the U.S. and its various trade partners.

Trade liberalization can take different forms and often a combination of policy tools is chosen. The final outcome often depends on the relative weight each of these tools is given. We compare two scenarios that give different weights to the two tools: extending quota levels or reducing over-quota tariff rates. Our results show that welfare benefits of lowering over-quota tariffs exceed those of increasing quota levels for most important sugar exporters. This result also holds for the U.S., an important sugar producing and importing country.

Further investigation:

This project is still in its beginning stages. Interesting extensions would be to add refined sugar policy data with the same kind of detail that we have for raw cane sugar. Countries such as Mexico, the Dominican Republic or other countries of interest could be taken out of their group so that their trade and welfare impacts could be analyzed at a country rather than regional level. Furthermore it would be valuable to try to include domestic U.S. policy with respect the government's program to buy sugar and sell it to the ethanol producers whenever the price falls below a threshold level. Incorporating this kind of policy detail helps gain a better understanding of true costs to tax payers and impacts on the sugar sector.

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Table 1--Average U.S. MFN Tariff on Sugar and Sugar Containing Products (Estimated)

	In-quota	Non-TRQ or over-quota
		--Percent--
Beet & can sugar (raw)	7.5	165.0
Beet & can sugar (refined)	5.9	153.0
Other Sweeteners	4.4	27.1
--*Sugar containing products*		
Nonalcoholic beverages	5.0	30.8
Cocoa powder and products	6.1	27.4
Other prepared food	8.4	33.6

Source: Calculations by USDA, Economic Research Service, using AMAD and WTO member-submitted ad valorem equivalent estimates, 2004-05.

Table 2. Tariff-Quota Allocations by Country and Year (2004-2007)

Country	2004	2005	2006	2007	2007 Shai
Argentina	45,281	54,171	77,258	55,112	4.12%
Australia	87,402	104,561	149,126	106,378	7.96%
Barbados	7,371	0	0	8,972	0.67%
Belize	11,583	13,857	19,764	14,098	1.05%
Bolivia	8,424	10,078	14,374	10,253	0.77%
Brazil	152,691	182,668	260,521	185,841	13.90%
Colombia	25,273	30,235	43,121	30,760	2.30%
Congo	7,258	7,258	7,258	7,258	0.54%
Costa Rica	15,796	15,796	26,950	19,225	1.44%
Cote D'Ivoire	7,258	7,258	7,258	7,258	0.54%
Dominican Republic	185,335	186,555	252,935	225,573	16.87%
Ecuador	11,583	13,857	19,764	14,098	1.05%
El Salvador	27,379	32,754	46,714	33,323	2.49%
Fiji	9,477	11,338	12,934	11,535	0.86%
Gabon	7,258	0	0	7,258	0.54%
Guatemala	50,546	60,469	86,242	61,520	4.60%
Guyana	12,636	15,117	21,560	15,380	1.15%
Haiti	7,258	0	0	7,258	0.54%
Honduras	10,530	12,597	17,967	12,817	0.96%
India	8,424	164	11,497	10,253	0.77%
Jamaica	11,583	2,950	19,764	14,098	1.05%
Madagascar	7,258	7,258	7,258	7,258	0.54%
Malawi	10,530	10,530	17,967	12,817	0.96%
Mauritius	12,636	15,117	21,560	15,380	1.15%
Mexico 6/	7,258	7,258	0	0	0.00%
Mozambique	13,690	16,378	23,357	16,662	1.25%
Nicaragua	22,114	26,456	37,731	26,915	2.01%
Panama	30,538	36,533	52,105	37,168	2.78%
Papua New Guinea	7,258	7,258	7,258	7,258	0.54%
Paraguay	7,258	7,258	7,258	7,258	0.54%
Peru	43,175	51,651	73,665	52,548	3.93%
Philippines	142,160	142,160	224,012	173,025	12.94%
South Africa	24,220	28,975	41,324	29,478	2.21%
St.Kitts and Nevis	7,258	0	0	7,258	0.54%
Swaziland	16,849	20,157	28,747	20,507	1.53%
Taiwan	12,636	15,117	13,953	15,380	1.15%
Thailand	14,743	17,637	25,154	17,943	1.34%
Trinidad-Tobago	7,371	0	12,577	8,972	0.67%
Uruguay	7,258	7,258	7,258	7,258	0.54%
Zimbabwe	12,636	15,117	21,560	15,380	1.15%

Source: USTR (allocations), U.S. Customs Service. Updated 2/5/2008.

Table 3. U.S. Raw Sugar TRQ Allocations for Fiscal Year 2008.

Countries	Metric Tons	Countries	Metric Tons
Raw Sugar (General)		*Raw Sugar (under NAFTA)*	
Argentina	45,281	Mexico	177,954
Australia	87,402		
Barbados	7,371	*Refined Sugar*	
Belize	11,583	Refined Global	7,090
Bolivia	8,424	Refined Canada	10,300
Brazil	152,691	Refined Specialty	65,159
Colombia	25,273	Total Refined TRQ	82,549
Congo	7,258		
Cote D'Ivoire	7,258	*Refined Sugar (under CAFTA)*	
Costa Rica	15,796	CAFTA TRQs (Calendar Year 2008)	
Dominican Republic	185,335	El Salvador	24,960
Ecuador	11,583	Nicaragua	22,880
El Salvador	27,379	Honduras	8,320
Fiji	9,477	Guatemala	33,280
Gabon	7,258	Total CAFTA	89,440
Guatemala	50,546		
Guyana	12,636		
Haiti	7,258		
Honduras	10,530		
India	8,424		
Jamaica	11,583		
Madagascar	7,258		
Malawi	10,530		
Mauritius	12,636		
Mozambique	13,690		
Nicaragua	22,538		
Panama	30,538		
Papua New Guinea	7,258		
Paraguay	7,258		
Peru	43,175		
Philippines	142,160		
South Africa	24,220		
St. Kitts & Nevis	7,258		
Swaziland	16,849		
Taiwan	12,636		
Thailand	14,743		
Trinidad-Tobago	7,371		
Uruguay	7,258		
Zimbabwe	12,636		
Rounding	1		
Total Raw Cane TRQ	1110359	All TRQ Sugar	1,460,302

Source: USTR (allocations), U.S. Customs Service (quantity entered).
Updated 2/5/2008

Table 4. HS6 Tariff Lines Included in Model

Code	HS6	GTAP Sector	Description
rawc	170111	SGR	Raw cane sugar (excl. added flavouring or colouring)
rawb	170112	SGR	Raw beet sugar (excl. added flavouring or colouring)
rfcb	170191	SGR	Refined cane or beet sugar, containing added flavouring or colouring, in solid form
sucr	170199	SGR	Cane or beet sugar and chemically pure sucrose, in solid form (excl. cane and beet sugar containing added flavouring or colouring and raw sugar)
mapl	170220	SGR	Maple sugar, in solid form, and maple syrup (excl. flavoured or coloured)
glus	170230	OFD	Glucose, glucose syrup < 20% fructose
gluo	170240	OFD	Glucose including syrup of 20%-50% dry weight fructose
frus	170250	OFD	Fructose, chemically pure
fruo	170260	OFD	Fructose, syrup > 50% fructose, not pure fructose
snes	170290	OFD	Sugar nes, invert sugar, caramel and artificial honey
cmol	170310	SGR	Cane molasses resulting from the extraction or refining of sugar
bmol	170390	SGR	Beet molasses resulting from the extraction or refining of sugar
gumc	170410	OFD	Chewing gum containing sugar, except medicinal
sugo	170490	OFD	Sugar confectionery not chewing gum, no cocoa content
cocp	180610	OFD	Cocoa powder, sweetened
cocc	180620	OFD	Chocolate and other food preps containing cocoa > 2 kg
cocf	180631	OFD	Chocolate, cocoa preps, block, slab, bar, filled, >2kg
cocu	180632	OFD	Chocolate, cocoa prep, block/slab/bar, not filled,>2kg
coco	180690	OFD	Chocolate/cocoa food preparations nes
inff	190110	OFD	Infant foods of cereals, flour, starch or milk, retail
doug	190120	OFD	Mixes and dough for bread, pastry, biscuits, etc.
malt	190190	OFD	Malt extract & limited cocoa pastry cooks products nes
cerf	190410	OFD	Cereal foods obtained by swelling, roasting of cereal
ceru	190420	OFD	Prep foods from unroasted
crib	190510	OFD	Crisp-bread
ginb	190520	OFD	Gingerbread and the like
wafr	190590	OFD	Communion wafers, rice paper, bakers wares nes
cofe	210112	OFD	Coffee prep. of extracts
cofx	210120	OFD	Tea and mate extracts, essences and concentrates
tomk	210320	OFD	Tomato ketchup and other tomato sauces
saun	210390	OFD	Sauces nes, mixed condiments, mixed seasoning
hcfp	210420	OFD	Homogenized composite food preparations
foon	210690	OFD	Food preparations nes
ofdo	999999	OFD	All Other OFD Lines

Note: nes is used to denote other products not elsewhere specified

Table 5. Model Countries

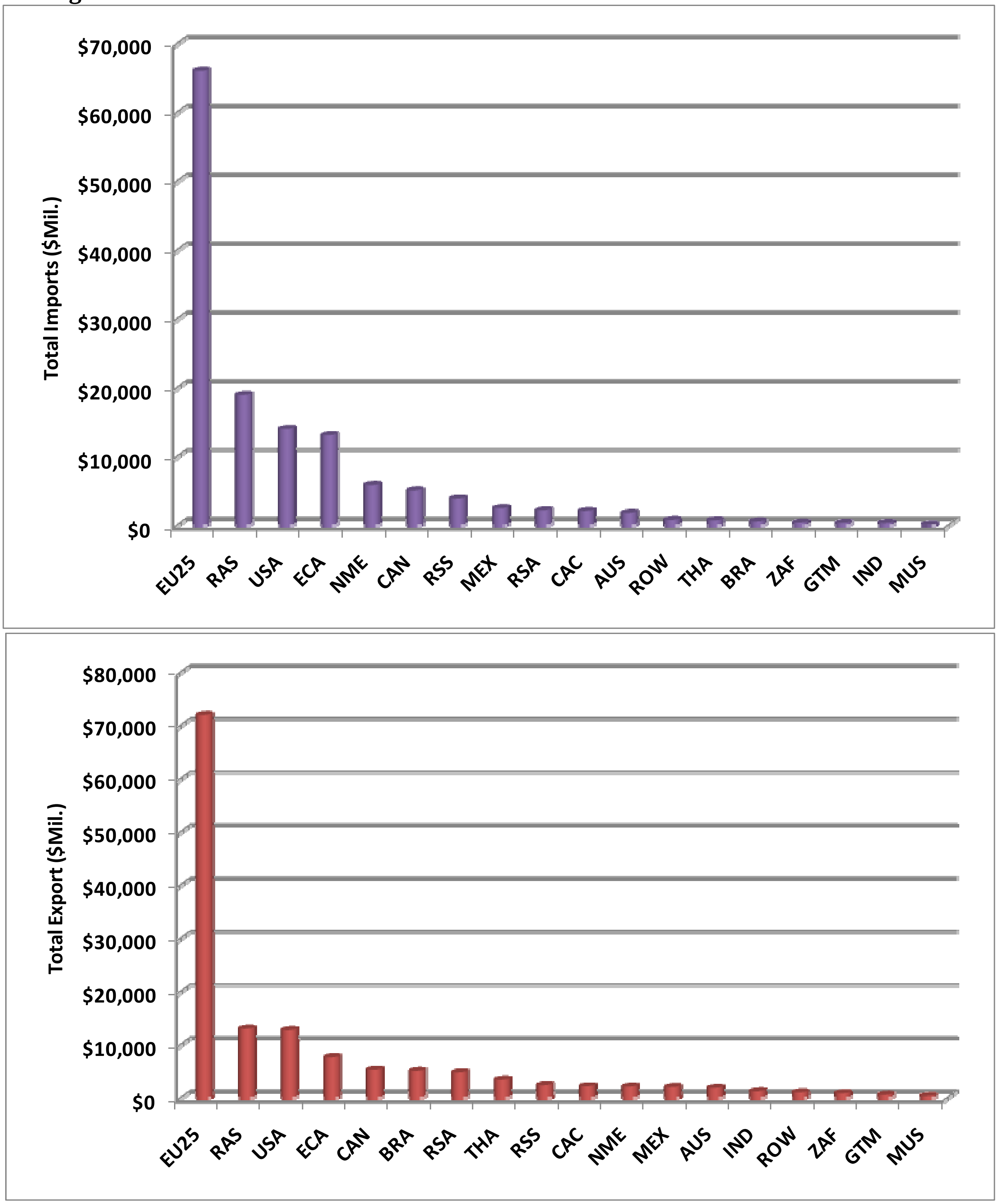
Number	ISO Code	Country Name
1	AUS	Australia
2	BRA	Brazil
3	CAN	Canada
4	IND	India
5	MEX	Mexico
6	MUS	Mauritius
7	THA	Thailand
8	USA	United States
9	GTM	Guatemala
10	ZAF	South Africa
11	CAC	Central America and Caribbean
12	ECA	Europe and Central Asia
13	EU25	European Union 25 Members
14	RAS	Rest of Asia
15	ROW	Rest of World (Oceania and Micronesia)
16	RSA	Rest of South America
17	RSS	Rest of Sub-Saharan Africa
18	NME	North Africa and Middle East

Table 6. TRQ Fill Ratios by Country/Region

Country/Region	Filling Rate (2004-06)	In-Quota Tariff	Over-Quota Tariff
AUS	0.990	0.032	0.782
BRA	0.990	0.033	0.816
CAC	0.964	0.033	0.807
GTM	0.990	0.039	0.955
IND	0.990	0.012	0.297
MEX	0.360	0.023	0.557
MUS	0.710	0.027	0.658
RAS	0.969	0.025	0.621
ROW	0.976	0.034	0.837
RSA	0.979	0.034	0.826
RSS	0.796	0.033	0.815
THA	0.940	0.035	0.865
ZAF	0.990	0.085	2.084

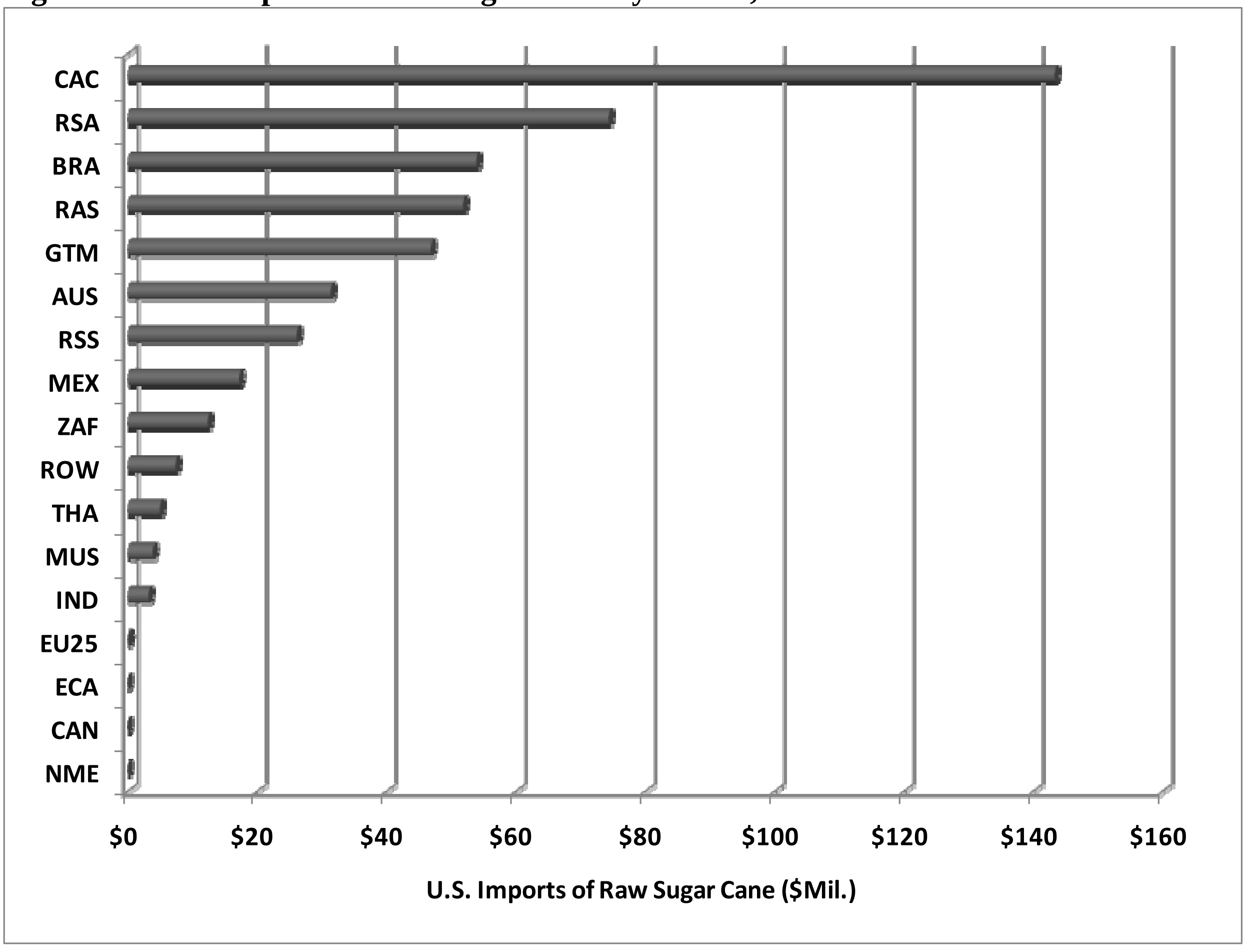
Source: Own calculations based on data by USTR and WITS, October 2008.

Figure 1. Total Import and Exports of Sugar and Confectionary Products, 2004-2006 Average



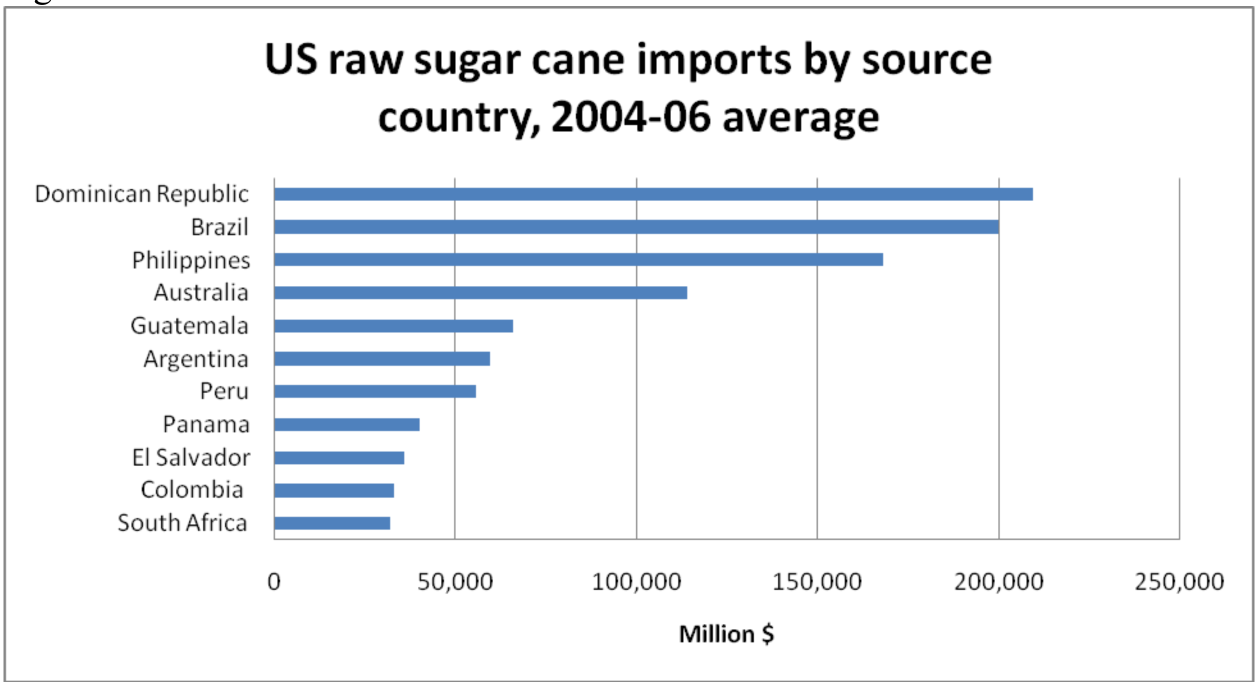
Source: WITS database, accessed October 2008.

Figure 2a. U.S. Imports of Raw Sugar Cane by Source, 2004-2006



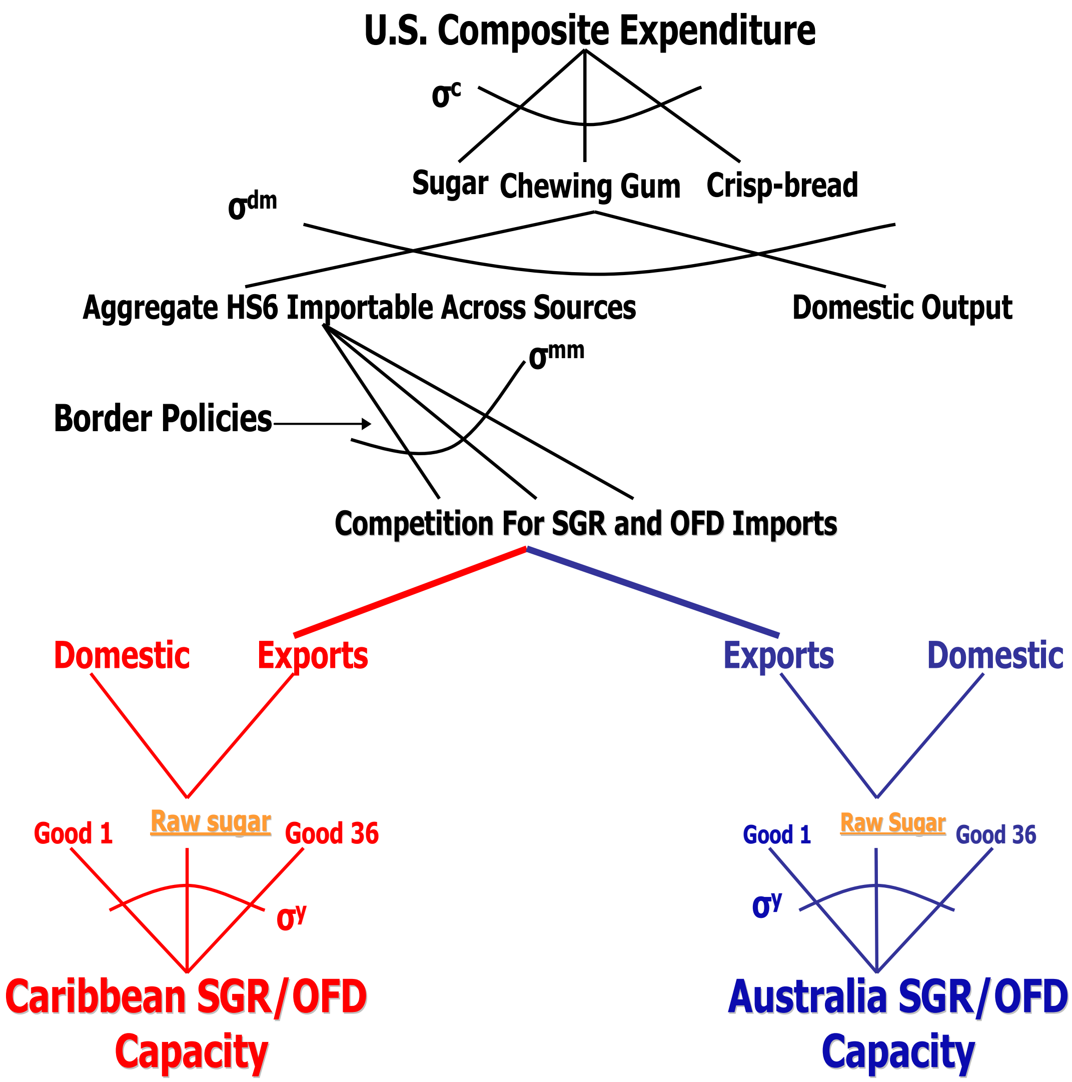
Source: WITS database, accessed October 2008.

Figure 2b:



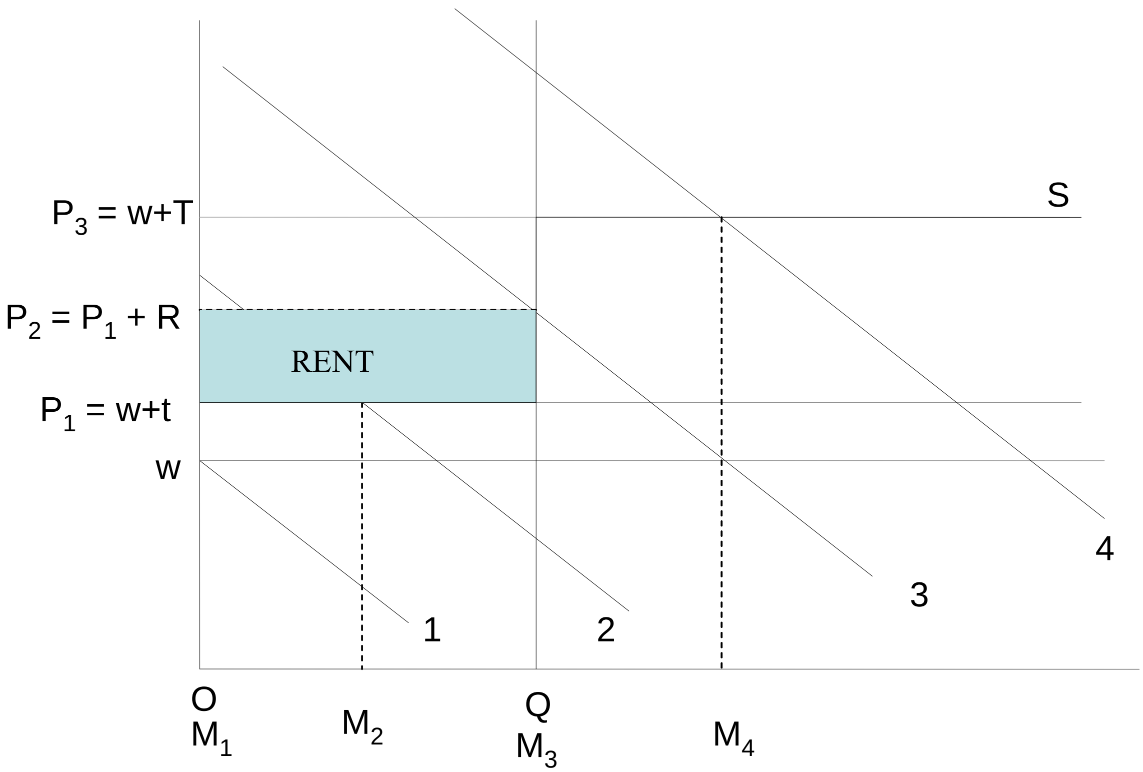
Source: WITS database, accessed October 2008.

Figure 3. Conceptual Framework of the Sub-Sector Sugar and Confectionary Model



Notes: The parameter σ^{Y} refers to the constant elasticity of transformation (CET). The parameters σ^{MM}, σ^{DM}, and σ^{C} enter the CES nest and depict substitution possibilities across import sources (σ^{MM}), between domestic and imported goods (σ^{DM}), and in final consumption (σ^{C}).

Figure 4. Import Demand With Tariff-Rate Quotas



Source: Based on Skully, 2001. p. 2

Figure 5. Welfare Results as a Percentage of Sugar Consumption, Scenarios 1 and 2

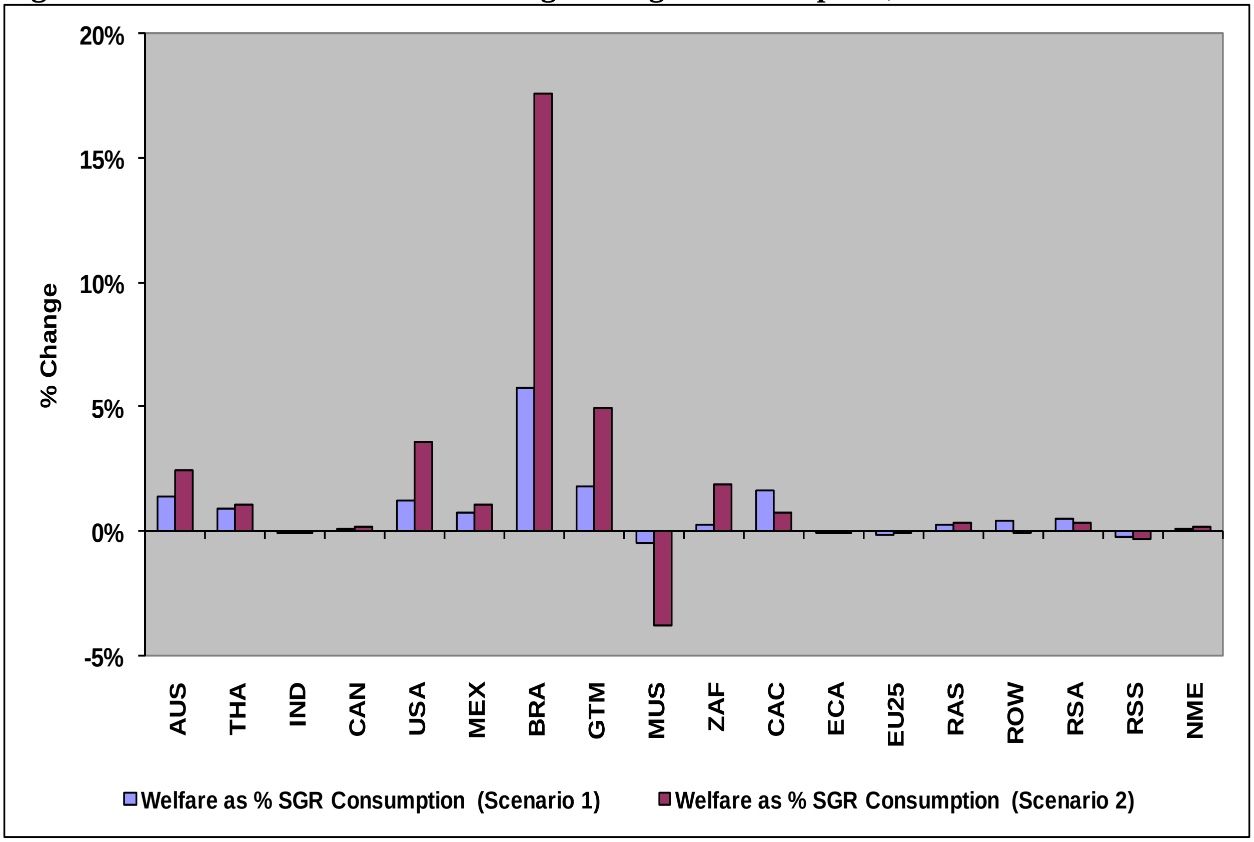


Figure 6. Sugar Production Response after Liberalization, Scenarios 1 and 2

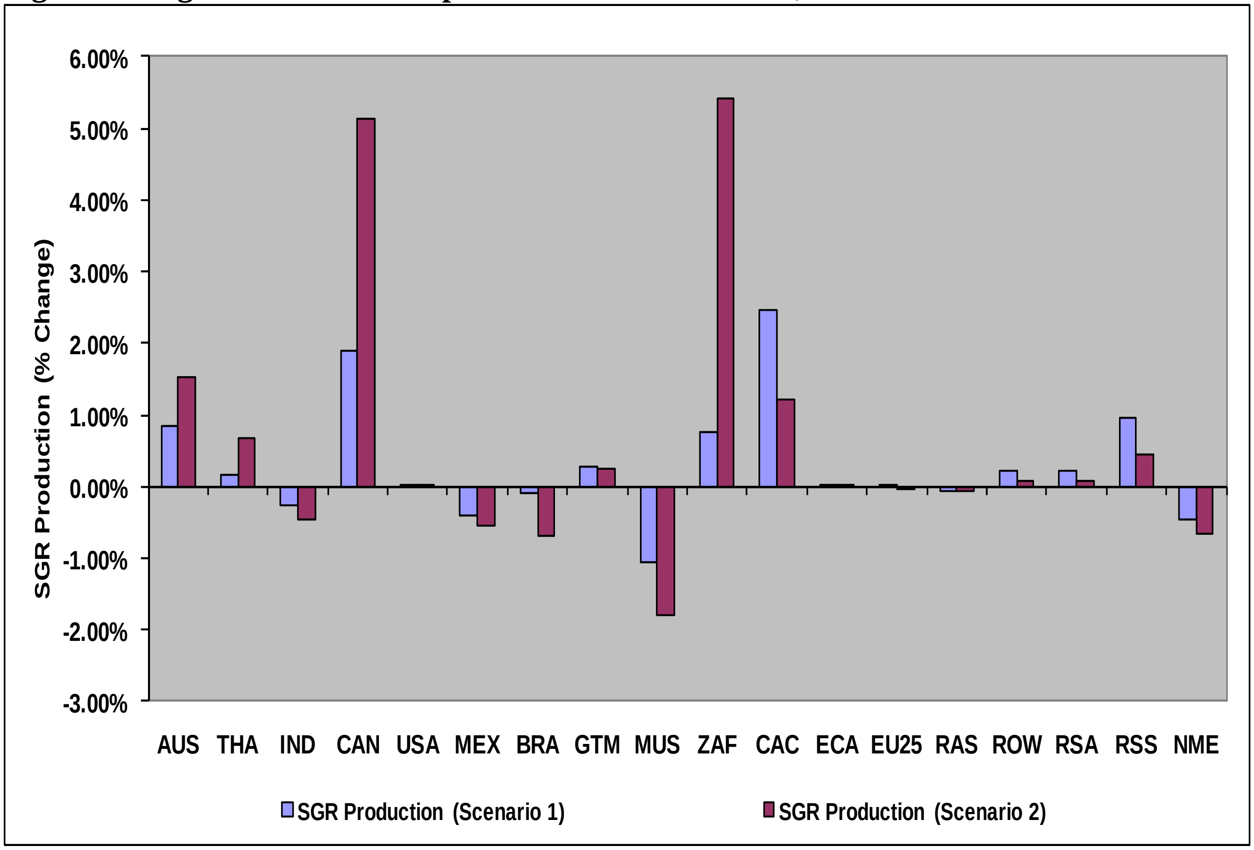


Figure 7. U.S. Bilateral Imports of Raw Sugar Cane, Scenarios 1 and 2