# IMPLEMENTING TARIFF RATE QUOTAS IN CGE MODELS: AN APPLICATION TO SUGAR TRADE POLICIES IN OECD COUNTRIES

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**Abstract**: We use Mixed-Complementarity-Problem programming to implement tariff rate quotas (TRQ) in the global CGE LINKAGE model. We apply the approach to tariff rate quotas in sugar markets in OECD countries. We calibrate the model on 2000 policy levels for OECD countries to reflect the full implementation of their World Trade Organization commitments. We look at reforms of TRQ and TRQ-like schemes in the EU, the United States, and Japan, as well as multilateral trade liberalization. We derive the impact of reforms on welfare, bilateral trade flows, and terms of trade. A 33-percent multilateral decrease of ad-valorem tariffs, combined with a 33-percent increase in imports under TRQ-like schemes in the EU, the United States, and Japan, induces a global welfare gain of about 889 million dollars. These three countries' trade policies create substantial trade diversion, which excludes many low-cost producers from trading opportunities. An expansion of their import quotas alone, without multilateral trade liberalization, induces welfare gains but preserves most of the trade diversion patterns. The latter diversion benefits some Least Developed Countries' producers because of granted bilateral TRQ allocations. In the context of greater market access, reductions in tariffs in the EU and the United States, and in border "surcharges" in Japan will have to be dramatic before they can significantly affect trade flows as compared to TRQ expansion. Full multilateral trade liberalization induces global welfare gains of about $3 billion.

**Keywords**: Doha, trade negotiations, liberalization, sugar, tariff rate quota, TRQ, CGE model

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## I. Introduction

We use a Mixed-Complementarity-Problem (MCP) programming approach (Rutherford; van der Mensbrugghe 2003b) to fully implement tariff rate quotas in the global CGE LINKAGE model (van der Mensbrugghe 2003a). Previous attempts to model TRQs in multi-country models have typically used linearized inequalities to implement TRQ reforms (e.g., Bach and Pearson; Elbehri et al.). Modeling TRQs remains a difficult task because of the discontinuous regime switching inherent in TRQ regimes. Further, accounting for TRQ rents requires additional model modifications to keep balanced flows in the global social accounting matrix.

We apply the methodology to tariff rate quotas in protected OECD sugar markets. Sugar prices in the European Union, Japan, and the United States are more than double those in the world market because of high protection to domestic producers relying on trade barriers. Such protection has distorted internationally traded sugar and in the process, has deprived lower-cost developing country exporters of growth opportunities. Hence the sugar application is policy relevant in the double context of agricultural reform and "development round" of the current negotiations of the World Trade Organization (WTO). We calibrate the model on 2000 trade policy levels for OECD countries to reflect the full implementation of commitments under the Uruguay round of the WTO. We consider several reform scenarios: OECD import quota expansion, decrease in OECD out-of-quota tariffs, their combination, and multilateral liberalization. The analysis derives the impact of reforms on production, trade flows, quota rents, prices, and welfare.

The LINKAGE Model is a global, multi-region, multi-sector, dynamic applied general equilibrium model. It is currently implemented in GAMS and its specification is virtually free of references to specific dimensions (region, sector, or time). The model is accompanied by an aggregation facility, which is used to aggregate the extensive GTAP dataset into a tractable dataset for simulation purposes. The output of the aggregation facility is the primary input for the model. The aggregation facility also produces some auxiliary data, such as population, and the model user is expected to provide values for all key elasticities. The dynamic version of the model also requires a series of assumptions, which are to be provided independently of the aggregation facility. The model is described in detail in van der Mensbrugghe (2003a). The results presented here are generated by a comparative-static version of the LINKAGE model, with the world divided into 16 countries/regions. The model incorporates 22 sectors, including a combined raw and refined sugar sector.

We find that a 33-percent multilateral decrease of ad-valorem tariffs, combined with a 33-percent increase in imports under TRQ-like schemes in the EU, the United States, and Japan, induces a global welfare gain of about 889 million dollars. These three countries' trade policies create substantial trade diversion, which excludes many low-cost producers from trading opportunities. An expansion of their import quotas alone, without multilateral trade liberalization, induces welfare gains but preserves most of the trade diversion patterns. The latter diversion benefits some Least Developed Countries' (LDCs) producers, because of granted bilateral TRQ allocations. In the context of greater market access, reductions in tariffs in the EU and the United States, and in border "surcharges" in Japan will have to be dramatic before they can significantly affect trade flows as compared to TRQ expansion. Full multilateral trade liberalization induces global welfare gains of about $3 billion.

In the following section, the paper first describes the essence of the implementation of TRQs in the model. Then salient features of trade policies in the three OECD countries follow. The fourth and fifth sections spell out important simplifying assumptions underlying the analysis and the policy reform scenarios considered. Results follow, and then the paper concludes with some policy implications for the current WTO negotiations.

To bring the introduction to a close, we summarize the contribution of our paper, which is twofold. First, there is the implementation of TRQs in CGE modeling using MCP programming. This is a methodological contribution. Second, we parameterize Japan's sugar policy, a complex system of tariffs, surcharges, and import targets implemented by parastatals acting as state-trading agencies. This new policy information and parameterization are then incorporated in a quantitative analysis of sugar policy reforms in OECD countries and in a multilateral setting. This is an empirical contribution to the long-standing debate on sugar policy.

**II. Modeling TRQs**

Tariff rate quotas (TRQs), an old policy instrument, were used in the Uruguay Round Agreement on Agriculture (URAA) to permit minimum market access and at the same time convert a wide-range of agricultural non-tariff barriers (NTBs) into tariffs (so-called tariffication) (Skully). Under the TRQ some level of imports is allowed at a relatively low or zero tariff rate, but any imported quantity above the quota is taxed at a higher or prohibitive rate. Let $XM^q$ represent the quota and $XM$ the level of imports. If $XM$ is less than $XM^q$, i.e., the level of imports is less than the quota level; the domestic price of imports is equal to the border price, $PWM$, times 1 plus the in-quota tariff rate, $\tau^{m\_i}$. If the level of imports is equal to the quota, i.e. the quota is binding, the domestic import price is equal to the border price times 1 plus the in-quota tariff rate plus a premium, $\tau^{m\_p}$. Should import demand exceed the quota, the out-of-quota tariff rate, $\tau^{m\_o}$ will be applied to all out-of-quota imports and the domestic price will equal the border price times 1 plus the out-of-quota tariff rate.

In a simple 1-sector static case, this can be formulated using the following equations (the multi-country extension is presented in Appendix A). Equations (1) and (2) define respectively the price of exports and imports, $PE$ and $PM$. The former is simply the world price, $WPE$, times the exchange rate, $ER$. The latter is also equal to the world price, $WPM$, times the exchange rate, adjusted for the appropriate tariff schedule. If imports are within quota, the appropriate tariff rate is simply the in-quota tariff rate, $\tau^{m\_i}$, and the premium will be zero. If imports are at quota or above, the appropriate tariff rate is the in-quota tariff rate plus a premium. While demand is constrained to the quota level, the import premium will be endogenous. If demand is above the quota level, the appropriate tariff rate is $\tau^{m\_o}$, i.e. the out-of-quota tariff. The equation holds in this case because the premium is equal to the difference between the out-of-quota tariff and the within-quota tariff.

(1) $PE = ER.WPE$, and

(2) $PM = ER.WPM\left(1+\tau^{m\_i}+\tau^{m\_p}\right)$.

Income, *YH*, in this simple model is equal to the value of production, *XP*, plus tariff revenues and a share, $\chi$, of the quota rents, *TRQY*, equation (3). Consumption, *XA*, is equal to income divided by the price of consumption, *PA*, equation (4). Armington demand, *XA*, equated with consumption, is split into two components assuming that domestic and import goods are imperfect substitutes. Equations (5) and (6) determine respectively demand for the domestic good, *XD*, and import demand, *XM*. The elasticity of substitution is given by $\sigma$. The Armington price, *PA*, is derived from the CES dual price formula, equation (7), where *PD* is the price of the domestic good and *PM*, derived above is the price of imported goods.

(3) $YH = PP.XP + ER.WPM.\tau^{m\_i}.XM^{i} + ER.WPM.\tau^{m\_o}.XM^{o} + \chi.TRQY$,

(4) $XA = YH / PA$,

(5) $XD = \alpha^{d}\left(\frac{PA}{PD}\right)^{\sigma} XA$,

(6) $XM = \alpha^{m}\left(\frac{PA}{PM}\right)^{\sigma} XA$, and

(7) $PA = \left[\alpha^{d} PD^{1-\sigma} + \alpha^{m} PM^{1-\sigma}\right]^{1/(1-\sigma)}$.

Analogous to the Armington assumption, output is allocated between the domestic and export market using a transformation function where the elasticity of transformation is given by γ. Equation (8) determines the producer price, *PP*. It is essentially an equilibrium condition where the CET dual price formula replaces the CET primal aggregation function. Equations (9) and (10) determine respectively the supply functions for the domestic market, *XD*, and the export market, *XE*. Note that the *XD* variable is the same in both equations (5) and (9) and in fact that supply equals demand equilibrium condition is subsumed in these two equations:

(8) $$PP = \left[\gamma^d PD^{1+\omega} + \gamma^e PE^{1+\omega}\right]^{1/(1+\omega)},$$

(9) $$XD = \gamma^d \left(\frac{PD}{PP}\right)^{\omega} XP, \text{ and}$$

(10) $$XE = \gamma^e \left(\frac{PE}{PP}\right)^{\omega} XP.$$

Constraint (11) determines the level of the in-quota imports. The constraint represents the orthogonality constraint for the in-quota import level, i.e., $\left(XM^q - XM^i\right)\tau^{m-p} = 0$. This condition holds if the premium is zero, in which case the in-quota import level is less than the quota, or if the in-quota import level equals the quota and the premium is positive. Similarly, constraint (12), determining the premium level, also represents an orthogonality constraint for the premium. If the level of imports exceeds the quota, i.e. the out-of-quota level of imports is positive, then the premium is strictly equal to the difference between the out-of-quota and within quota rates. If the out-of-quota level of imports is zero, then the premium is endogenous and lower than the difference in the two rates. Equation (13) determines the level of the out-of-quota imports by residual. Equation (14) describes the value of the quota rents. There are three situations. If the quota is not binding, the premium rate is zero and the rents will be zero. If the quota is binding but imports are equal to the quota, the premium is endogenous and the rents are simply equal to the quota level times the premium rate. The third situation is when imports exceed the quota. In this case, the premium is equal to the difference in the two rates, i.e. the holders of the quotas can import at the lower within-quota rate but sell at the higher out-of-quota rate and therefore pocket the revenues generated by the difference. These four equations are

(11) $XM^{i} \leq XM^{q}$ with $\tau^{m-p} \geq 0$,

(12) $\tau^{m-i} + \tau^{m-p} \leq \tau^{m-o}$ with $XM^{o} \geq 0$,

(13) $XM = XM^{i} + XM^{o}$, and

(14) $TRQY = ER.WPM.\tau^{m-p} XM^{q}$.

Next we explain how parameter $\chi$ is calibrated in the model, keeping the database unchanged and first assuming the quota is binding but no out-of-quota imports occur. In this case there are two calibration choices. One could assume knowledge of the premium and the rent share parameter is calibrated, or vice versa. In any case, the model assumes that all quota rents accrue to the government. In a single household model this will have no in-country welfare implications since under the standard closure rule changes to the government fiscal position are financed through lump sum taxes. In the base year, the following knowledge is given: (i) trade at world prices inclusive of the premium rents transferred to the exporter, R, (ii) import tariff collections inclusive of the premium rents captured by the importer, Y, and (iii) the in-quota tariff rate, $\tau^{i}$.

The following two identities must hold in any case:

(15) $R = W + (1-\chi)\tau^{p} W$, and

(16) $Y = \tau^{i} W + \chi \tau^{p} W$.

where $W$ is the value of imports at world prices exclusive of the import tariff and premium, and $\tau^{p}$ is the premium rate. Equation (15) states that the observed value of imports at world prices is equal to the value of trade exclusive of the tariff premium income plus the share of the quota rents captured by the exporter. Equation (16) reflects the value of government revenues. It is equal to the revenues generated by the in-quota imports plus the importer's share of the quota rents. This is a system of two equations in two unknowns, leading to the following solution:

$$\tau^p = \frac{Y - \tau^i R}{\chi R - (1-\chi)Y}, \text{ and } W = \frac{\chi R - (1-\chi)Y}{\chi - (1-\chi)\tau^i}.$$

In the alternative, the premium, $\tau^p$ is known and the distribution share, $\chi$, is unknown. The same two initial equations can be solved for $\chi$ and *W*:

$$\chi = \frac{(1+\tau^p)Y - \tau^i R}{\tau^p (Y+R)}, \text{ and } W = \frac{Y+R}{1+\tau^i+\tau^p}.$$

If over-quota imports occur, the in- and over-quota tariffs need to be specified. The premium will simply be the difference in the two tariff rates. The quota needs to be specified. From this information, one can deduce the share of the quota rent revenues accruing to the importing country. Appendix A extends this basic framework to a global model with TRQs assigned to bilateral flows. Van der Mensbrugghe (2003b) provides the GAMS code to implement the TRQs.

## III. Sugar Trade Policies in the EU-15, Japan, and the United States

The policy description focuses on trade distortions in the EU, the United States, and Japan affecting sugar imports by these countries. The policies in the three countries are based on TRQs (EU, the United States) or TRQ-like scheme (Japan). Mitchell provides a detailed description of all trade and domestic sugar policies for major players in world markets. When relevant to the analysis the note mentions features of domestic programs or export market distortions, which interact with the TRQs.

***EU TRQ policy***

TRQs are the cornerstone of EU sugar protection along with production subsidies and supply controls (so-called quota A and B sugar), and export subsidies (Mitchell). The EU TRQ scheme sets bilateral import quotas. Preferential access at guaranteed high price serves as "development assistance" to 46 countries from Africa, the Caribbean, and the Pacific (ACP) originally secured under the 1975 Lomé Convention. The Sugar Protocol (SP) of the Lomé Convention specified original quotas for 1.295 million tons of white sugar equivalent, and an additional 10,000 tons for India. An additional import allocation was made of between 200,000 and 350,000 tons of sugar to primarily ACP countries in 1995, under 'Special Preference Sugar' (SPS). This allocation was not permanent, the quantity could vary based on import needs, and the price paid for SPS sugar was 85 percent of the SP guaranteed price. The EU accepted the WTO import commitments of the new EU members joining in 1995, including a tariff quota of 42,000 tons from Brazil, with a within quota tariff rate of 98 ECU per ton (49 percent ad valorem equivalent in 2000). Several countries in the Balkans have temporary access to the EU market and imports under this program totaled about 100,000 tons in 2001/02. In total, the EU permanent commitment is 1.39 million tons (white sugar equivalent) plus additional quantities of up to 450,000 tons of temporary imports. All out-of-quota imports face a specific tariff of 346 Euro or 174 percent in ad valorem equivalent in 2000. The model uses these ad valorem tariff values.

These EU import commitments were expanded by the Everything But Arms initiative (EBA) in 2001. The EBA initiative allows duty-free access to the EU sugar market to the 48 least developed countries (39 ACP countries). Initially, EBA imports enter duty-free but are limited by quotas, and counted against the SPS sugar quota (a zero sum effect on imports but with distribution effects within exporters). The EBA quota will increase annually until full duty-free access for white and raw sugar is allowed in 2009.

Virtually all-preferential sugar imports are re-exported with a unit export subsidy corresponding to the difference between the preferential import price and the prevailing world price. The EU has WTO commitments on subsidized exports, both in terms of maximum subsidized volume and total subsidy outlays. The export volume commitment covers the re-exported preferential imports and EU sugar production under the so-called quota A and B. The latter is too costly to be competitive on world market. An increase in EU preferential imports (i.e., an increase in TRQ quota) would then induce a direct offset of this subsidized domestic production under quotas A and B to meet the WTO commitment limiting export volume. Following this increase in preferential imports (increased TRQ quota), the EU aggregate supply of unsubsidized sugar (so-called C sugar) should increase moderately. The latter occurs because some but not all EU producers can compete at world price levels and replace the lost quota sugar by production and exports of C sugar (Frandsen et al.). Hence aggregate domestic supply in the EU should decrease as a result of increasing preferential imports but by a lesser amount than the TRQ quota increase.

***Japan import policy***

The Agriculture and Livestock Industries Corporation (ALIC) acts as a state-trading agency in the Japanese sugar market, with a monopsony on imported raw sugar purchases and a monopoly on the domestic resale of these raw sugar imports. The Ministry of Agriculture Forest and Fisheries (MAFF) determines an annual import volume target, usually around 1,500,000 metric tons (Dyck). MAFF determines the Japanese price of raw sugar imposing a hefty surcharge over the world price of raw sugar (about 84 percent in ad-valorem equivalent in 2000 (Fukuda, Dyck, and Stout; Dyck)). If imports exceed the target level, a second surcharge is imposed on above-target imports bringing the total out-of-target surcharge to 155 percent ad-valorem equivalent. This secondary surcharge is applied if a processing firm goes over its firm-level targeted imports.

However, if all firms exceeded their targets, they would all be paying the secondary surcharge. *De facto*, ALIC-MAFF's trade policy for raw sugar mimics a TRQ scheme. The official tariff on raw sugar imports is zero. Refined sugar imports are effectively barred by prohibitive tariffs (about 623$/metric ton). These policy instrument levels for Japan are not notified to the WTO since officially they are not tariffs and their levels are approximate because of unavailable data (Dyck).

***U.S. TRQ Policy***

In the Uruguay Round Agreement on Agriculture (URAA), the United States agreed to maintain minimum imports of 1.139 million metric tons of raw value sugar imports including (22,000 metric tons of refined sugar). The raw sugar TRQ was allocated to 40 quota-holding countries based on their historical export shares during 1975-81 when trade was relatively unrestricted. The duty of 0.625 cents per pound, raw value, continues on quota imports. Most countries continue to avoid the duty because of General System of Preference (GSP) or Caribbean Basin Initiative (CBI) programs. The duty on raw sugar above the tariff-rate quota was 17.62 cents per pound beginning in January 1995 and lowered by 0.45 cents per pound each year until it reached 15.36 cents per pound in 2000 (190 percent in ad-valorem equivalent). The refined sugar above rate tariff was 18.62 cents/lb in 1995 and declined by 0.48 cent per year through 2000 to 16.21 cent/lb. The over-quota tariff remains prohibitive even with a world price of about 5 cents per pound (assuming a raw sugar market price of 22 cents per pound and a transportation price of 1.5 cents per pound).

The North American Free Trade Agreement (NAFTA) became effective on January 1, 1994, and most trade barriers between Canada, Mexico, and the United States are being eliminated over the subsequent 15 years. The NAFTA sugar provisions were altered by a side-letter agreement prior to the start of the NAFTA Agreement. According to the NAFTA side-letter, Mexico's low-tier tariff sugar exports to the United States are restricted by Mexico's 'net surplus production' of sugar. The net surplus is defined as Mexico's production of sugar less its consumption of sugar and high fructose corn syrup. From FY 2001 through 2007, Mexico is to have duty-free access to the U.S. market for the amount of its surplus, up to a maximum of 250,000 metric tons raw value. Beginning in FY 2008, Mexico will have duty-free access with no quantitative limit. The high-tier tariff schedule for raw and refined sugar has been declining by an equal annual amount from 10.58 and 11.21 to zero, respectively, over the transition period to duty free access in 2008. Out-of-quota imports from Mexico have been occurring since 1998-99. The model is calibrated to reflect the out-of-quota imports from Mexico induced by the lower out-of-quota tariff faced by Mexican sugar exports to the U.S. market. The tariff is set at the 2000 level (ad-valorem equivalent to 133 percent).

**IV. Additional Assumptions**

A set of simplifying assumptions pertains to domestic policy programs. The GTAP 5.3 database reports production subsidies, input subsidies, and direct payments to capital and land, but does not account for supply control such as sugar marketing allotments in the United States or production quotas in the EU. Given the focus on import policies, the domestic sugar distortions are kept as described in the GTAP 5.3 database.

Another difficulty arises with export subsidies and EU export subsidy commitments under the URAA. Whenever the EU increases its preferential imports, it has to decrease its subsidized production (quotas A and B), by roughly the same volume to meet subsidized exports volume commitments. Subsidized production equivalent to the increased preferential imports could not be exported without subsidy. The current analysis does not address this important aspect of the EU policy.

The sectoral definition of sugar crops and sugar in the GTAP 5.3 database is heterogeneous across countries. The sugar-crop sector includes raw cane sugar in some countries and as a result shows some trade flows for these nontraded crops. Further, the sugar sector includes refined sugar in some countries and both raw and refined sugar in others. To avoid this inconsistency, we aggregate the sugar crop and sugar sector in an aggregate sugar sector. Besides sugar, the sectoral disaggregation is similar to that of van der Mensbrugghe (2003a).

A final issue is the sharing (parameter $\chi$ in equation (3)) of the rent between importers and exporters, which is parameterized in the model. In the EU and the United States, the sharing is 75% to importers and 25% to exporters, except for Mexican imports going to the United States, for which the sharing is 50%. In Japan, 100% of the rents go to importers. This parameter, is important in the analysis since it influences the incentive to export and the inter-country welfare implications of changing TRQ schemes. The range of parameter $\chi$ is limited by the calibration as explained in the model section since it is found by solving a set of equations such as (15)-(16) for each country.

**V. Scenarios**

For each country, the analysis considers three types of market access reform scenarios: (i) a 33-percent increase in EU and U.S. TRQs, and in the Japanese import target. We call these scenarios EUQTA, USQTA, and JPQTA, respectively; (ii) a 33-percent decrease in out-of-quota tariffs (out-of-target surcharge in Japan) referred to as (EUTAR, USTAR, JPTAR scenarios); (iii) a scenario combining reforms described in (i) and (ii) (EULIB, USLIB, JPLIB scenarios). Then, a "QUAD" market access scenario is run, combining the three countries' reforms (QDQTA, QDTAR, QDLIB scenarios).[2] The last two scenarios look at multilateral reforms. First we combine a 33-percent multilateral tariff reduction in all countries along with the QUAD TRQ

[2] Canada is not included in the definition of the QUAD used here.

reform (MLTLT scenario). The last scenario is a full liberalization scenario with all tariffs set to zero (FLLB).

The scenarios are shown in Table 1 with the value of the policy parameters implied by each reform starting from the baseline. Bold characters indicate the changing parameter values. A caveat on the TRQ scenarios is that the state of the world regarding import flows in the baseline determines to a large extent which exporting countries will benefit from the expansion of the aggregate TRQ in the importing country. Our modeling approach does not allow for least-cost producers to enter a market if the latter did not already export to that market prior to the TRQ expansion. Hence we are simulating the deleterious impact of an expansion of the existing TRQ systems and their trade preferences, rather than a genuine increase in market access open to all potential exporters. The latter is the essence of the multilateral trade reform scenarios.

**VI. Results**

Results are presented in Tables 2-7. The tariff reforms in each individual country have a moderate effect on production (Table 3), trade flows (Table 2 and 4), quota rents (Table 2), welfare (Tables 5 and 6), and prices (Table 7). By contrast, the quota reforms induce much larger changes in the variables. Results of individual country's reforms are nearly additive in two directions. First, for each country, the effects on major variables of the combined quota expansion and tariff reduction (EULIB, USLIB, and JPLIB scenarios) are the sum of the effect of each individual instrument reform (EUQTA and EUTAR, USQTA and USTAR, JPQTA and JPTAR). Second, The QUAD scenarios (e.g., QUDQTA) are also nearly additive in the effects of the corresponding reform in each country (the sum of EUQTA, USQTA, and JPQTA effects).

In the combined reforms (tariff reduction cum quota expansion), the quota expansion is the binding policy instrument for the EU, Japan, and the United States, noting the NAFTA exception (out-of-quota imports from Mexico to the United States). A policy implication is that out-of-quota tariff cuts for sugar should be much more substantial than what we have modeled to become effective in a TRQ reform combining tariffs reductions and quota expansion. Table 2 shows the average unit rent premium remaining with each reform. The dispersion within exporters is very limited except for Brazilian exports to the EU receiving lower rents. The out-of-quota tariffs should fall below the rent value shown in Table 2 to have an effect on trade flows.

In the scenarios involving tariff-reductions alone, limited out-of-quota imports occur in Japan, originating from Thailand, Australia-New Zealand, Rest of Latin and Central America, and the Rest of Asia in decreasing order. In the same scenarios, out-of-quota imports to the EU come from the Rest of sub-Saharan Africa, Rest of Latin and Central America, Rest of Asia, SACU, India, East and Central Europe (ECE), and MENA countries in decreasing order. What is striking is the diversity of patterns of export expansion opportunities corresponding to tariff liberalization in each of the three liberalizing countries. Finally in the United States, Mexican sugar exports are the only out-of-quota import expansion resulting from the lower tariffs.

As shown in Table 3, production expands moderately with the reforms induced in the three OECD countries. Hence a 33-percent tariff cut or a 33-percent quota expansion would not induce great changes in production flows and income-generating opportunities for sugar exporters. The multilateral scenarios (last column of Table 3) shows the varying fortune of sugar exporters in different policy regimes. A more integrated world market as implied by the last scenarios induces production and trade expansion by the least-cost producers (Brazil, Thailand, Australia-New Zealand, and Rest of Latin and Central America). However, output contraction is induced in countries favored by the EU and U.S. TRQ systems, but which are not truly competitive without preferential trade. The contrast between the QLIB column and the last two columns in Table 3 vividly makes this point on misallocation of resources induced by current preferential trade agreements. ECE, and MENA countries cannot produce competitively and see their output contract under multilateral tariff reductions as compared to the baseline situation.

The rest of Sub-Saharan Africa sees its production expansion falls moving from the QUAD liberalization to the partial multilateral liberalization (MLTLT) but eventually pick up again as prices rise with full liberalization (FLLB) (last three columns of Table 3). Export patterns reflect production patterns with a considerable expansion of exports for low-cost producers under the MLTLT and FLLB scenario relative to the other scenarios. The exception is the Rest of Central and Latin America who fares well under both the QUAD liberalization (QUDLIB) and the multilateral reforms (MLTLT and FLLB) as shown in the last three columns of Table 4.

The welfare effects of the reforms are first measured using changes in real GDP at base-market prices relative to real GDP in the baseline. These are shown in Table 5. These effects are modest by design since the shocks are incremental, resulting in moderate effects on trade and resource allocation. Full multilateral trade liberalization scenarios (last column of Table 5) would induce about 1.6 billion dollars of additional real GDP with the largest gains going to the liberalizing countries, ECE and Brazil. The reforming countries, gain by reducing inefficiencies in both consumption and production.

The gains in the QUAD countries under full liberalization are larger than those obtained under the narrower QUAD reforms because of the lowest tariffs achieved in the former. However, partial liberalization (MLTLT) induces higher sugar import unit cost than the QUAD reforms do and the welfare gains under MLTLT are lower relative to those under the QUAD reforms –a trade off between lower tariffs and higher import unit cost before tariffs. The EU appears to gain more from its reforms than the United States and Japan do, which is consistent with the respective size of their TRQ imports. The EU has the largest quota.

In Table 6, we provide Equivalent Variation (EV) to the policy changes (the difference in expenditures at base prices to reach the new and old utility levels). Aggregate results are larger (2.948 billion dollars of aggregate welfare gains). However, the gains for the United States appear smaller when measured by EV relative to the real GDP measure. This result is caused by negative feedback effects of the reforms on nominal income and prices in the sugar, food, and service sectors via the balance of trade constraint. The United States sees factor income increases (an appreciation) because of the stronger demand for its manufacturing good exports –Brazil and other exporters increase their imports of manufacturing goods. The United States has a large service sector, which can absorb higher factor prices and a resulting increase in service price because the latter sector has a large nontraded component. The net effect of lower sugar price, higher manufacturing, and service prices is barely positive for the United States in the partial multilateral liberalization and slightly negative for the full liberalization scenario. The combination of these offsetting effects appears less favorable with the EV measure than with the real GDP measure. By contrast, Brazil appears to gain more with the EV measure relative to the real GDP metric. Note that these effects are small relative to the baseline income levels, especially for the three reforming OECD countries.

Our results on the U.S. policy and partial multilateral policy reforms are consistent in directions and magnitudes with those of Elbehri et al. for comparable scenarios, keeping in mind that they did not model the Japanese sugar policy and used different tariff values. However, for the EU we have different results especially for reforms with tariff reductions. The differences originate in the assumption regarding out-of-quota imports by the EU. Elbehri et al. include intra-EU trade in EU international trade resulting in the EU importing above its TRQs, which it is not in reality. The EU TRQ expansion has little impact in this context since EU imports exceed the quota already. Our welfare results are also consistent with Borrell and Pearce.

The price effects of the reforms indicate that full liberalization would induce sizable increases in import and export unit cost for sugar. Given the model structure with differentiated import and export goods, we have different prices for imported sugar and exported sugar. The import price for the three QUAD countries would increase by 12 percent (EU), 36 percent (the United States), and 11 percent (Japan). The export unit price would increase substantially for major exporters as shown in the last column of Table 7. The range of increases is relatively wide expressing the variation of cost structures across countries, and has an average increase of 15 percent for the exporters shown in the Table.

We also ran a homogeneous-good version of the model (see appendix B for details) in order to compute a "true" world price rather than an index of bilateral prices as implied by the Armington structure. We ran a full multilateral trade liberalization scenario. This exercise leads to a 21 percent increase in the world price of sugar. It is also worth noting that welfare gains quadruple with the latter version of the model to reach $13.6 billions, which could be consider an upper bound on welfare gains from liberalizing sugar markets. This exercise also show how sensitive welfare effects can be to assumptions regarding trade structure.

**VII. Conclusions and Policy Implications**

We used MCP programming to implement TRQs in the global CGE LINKAGE model. Then we used this methodological development to analyze TRQ schemes in sugar markets in the EU, United States, and Japan. The parameterization of the Japanese policy is an original aspect of our paper. We looked at reforms of TRQ and TRQ-like schemes in these countries, as well as multilateral trade liberalization. We found that a 33-percent multilateral decrease of ad-valorem tariffs, combined with a 33-percent increase in imports under TRQ-like schemes in the EU, the United States, and Japan, induces a global welfare gain of about 889 million dollars. But we also found that these three countries' trade policies create substantial trade diversion, excluding most low-cost producers from trading opportunities. The current diversion benefits some LDCs' producers because of granted bilateral TRQ allocations. We also found that full multilateral trade liberalization induces global welfare gains of about $3 billion.

Three major policy implications emerge from our analysis. First, market access with TRQ expansion in the EU, the United States, and Japan has a significant effect on trade expansion, but it continues the trade diversion intrinsic to the bilateral sugar TRQs put in place by the EU and the United States. Africa clearly would benefit from such an export expansion under the EU quota expansion. This is less true under the multilateral liberalization scenario. Conversely Brazil fares poorly under the TRQ expansions, but does much better in the multilateral tariff reduction in terms of export market expansion. Hence, there is an issue of transfer and redistribution within developing exporters of sugar. Currently the lowest-cost exporters are kept out of the EU market, which benefits several LDCs exporters.

Second, reforms should consider dramatic cuts in sugar tariffs relative to the quota expansion targeted by market access. Relative decreases in out-of-quota tariffs of the same order as the quota expansion will have very little or no impact on trade and welfare. To have any effect on sugar trade the tariff (surcharge in Japan) cuts will have to be very large and be larger in the United States than in Japan and the EU. Third and last, the Japanese surcharge and state trading have to be brought into the URAA framework, tariffied and notified to the WTO. It is amazing that Japanese policy makers got away with such lack of policy discipline until now.

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## Appendix A. Implementation of TRQs in a Global CGE Model

### *Global model*

This appendix shows how to implement TRQs in a global model with TRQs assigned on a bilateral basis.

Equation (A1) represents the bilateral domestic price of imports inclusive of import taxes and the quota premium. It is equal to the price of exports produced in region *r* destined for region *r*' times the adjustment factors. The in-quota and out-of-quota tariff rates are bilaterally specified (as is the quota level), and the quota premium will also be bilateral. Nominal national income will depend on how the bilaterally determined quota revenues are shared with trading partners.

(A1) $$PM_{r,r'} = PE_{r,r'}\left(1+\tau^{m\_i}_{r,r'} + \tau^{m\_p}_{r,r'}\right),$$

(A2) $$YH_r = PP_r XP_r + \sum_{r'} PE_{r',r}\left(\tau^{m\_i}_{r',r} WTF^{i}_{r',r} + \tau^{m\_o}_{r',r} WTF^{o}_{r',r}\right) + \chi_{r',r} TRQY_{r',r}\text{, and}$$

(A3) $$XA_r = YH_r / PA_r .$$

The same double-nested Armington structure is maintained in the global model. Equations (A4)-(A6) describe the top level CES nest. Equations (A7) and (A8) describe the second-level nest where WTF represents the flow from region *r*' to region *r*, i.e. exports are read across a row and imports down a column.

(A4) $$XD_r = \alpha^d_r \left(\frac{PA_r}{PD_r}\right)^{\sigma_r} XA_r ,$$

(A5) $$XMT_r = \alpha^m_r \left(\frac{PA_r}{PMT_r}\right)^{\sigma_r} XA_r ,$$

(A6) $$PA_r = \left[\alpha^d_r PD_r^{1-\sigma_r} + \alpha^m_r PMT_r^{1-\sigma_r}\right]^{1/(1-\sigma_r)},$$

(A7) $$WTF_{r',r} = \alpha^w_{r',r}\left(\frac{PMT_r}{PM_{r',r}}\right)^{\rho_r} XMT_r\text{, and}$$

(A8) $$PMT_r = \left[\sum_{r'} \alpha^w_{r',r}(PM_{r',r})^{1/(1-\rho_r)}\right]^{1/(1-\rho_r)} .$$

Similarly equations (A9)-(A11) describe the top-level CET nest, and equations (A12)-(A14) the second level CET nest which determines export supply from market *r* to market *r*', with the composite export price (equation (A14)):

(A9) $$PP_r = \left[\gamma^d_r PD_r^{1+\omega_r} + \gamma^e_r PET_r^{1+\omega_r}\right]^{1/(1+\omega_r)},$$

(A10) $$XD_r = \gamma^d_r \left(\frac{PD_r}{PP_r}\right)^{\omega_r} XP_r ,$$

(A11) $$XET_r = \gamma_r^e \left( \frac{PET_r}{PP_r} \right)^{\omega_r} XP_r ,$$

(A13) $$WTF_{r,r'} = \gamma_{r,r'}^w \left( \frac{PE_{r,r'}}{PET_r} \right)^{\mu_r} XET_r , \text{ and}$$

(A14) $$PET_r = \left[ \sum_{r'} \gamma_{r,r'}^w PE_{r,r'}^{1+\mu_r} \right]^{1/(1+\mu_r)} .$$

Equations (A15) through (A18) correspond to equations (11)-(14) of the original model and need no further explanation. They are all simply indexed by region of origin and destination.

(A15) $$WTF_{r,r'}^i \le WTF_{r,r'}^q \quad \text{with} \quad \tau_{r,r'}^{m\_p} \ge 0 ,$$

(A16) $$\tau_{r,r'}^{m\_i} + \tau_{r,r'}^{m\_p} \le \tau_{r,r'}^{m\_o} \quad \text{with} \quad XM_{r,r'}^o \ge 0 ,$$

(A17) $$WTF_{r,r'} = WTF_{r,r'}^i + WTF_{r,r'}^o , \text{ and}$$

(A18) $$TRQY_{r,r'} = WPE_{r,r'} \tau_{r,r'}^{m\_p} WTF_{r,r'}^q .$$

Equation (A19) describes the balance of payments equation and as above can be derived from a combination of the equations above and therefore represents Walras' Law. The model assumes that the current account is in balance for each region.

(A19) $$\sum_{r'} PE_{r,r'} WTF_{r,r'} = \sum_{r'} PE_{r',r} WTF_{r',r} - \sum_{r'} \left(1 - \chi_{r',r}\right) TRQY_{r',r} .$$

**Appendix B. Homogenous-good version of the model**

This second appendix reports sugar trade liberalization analysis obtained with a homogenous-commodity version of the LINKAGE model. The LINKAGE model was reformulated to accommodate the homogenous commodity assumption in sugar with the following major changes. The bilateral trade flows in sugar are replaced by imports from and exports to a single world market with a single prevailing world market price. Net trade in sugar replaces two-ways trade. The policy coverage is represented by ad-valorem equivalent of the trade distortions as shown in GTAP 5.3, with a modification to remove intra-EU sugar trade. In the latter country, the ad-valorem equivalent calculation of the trade distortions excludes intra-EU trade to provide a better representation of the trade barriers faced by the rest of the world exporting to the aggregate EU. Results have illustrative value and represent a long-term impact given that price responses are high in the model. The results show that both versions (Armington, homogeneous-good) of the model provide consistent results on welfare, trade flows, and production relocation despite the different treatment of trade and policies.[3] The single price effect is the distinct feature of the homogeneous-good version of the model.

[3] SACU is the exception. The Armington model predicts an expansion of SACU output and trade whereas the homogeneous commodity model predicts the opposite.

We report on a full multilateral trade liberalization scenario.

**Impact on production and consumption**

As expected, results provide the same directions of changes as the Armington version of the model does, but with sharper contrasts. The full liberalization scenario induces the virtual elimination of sugar production in the EU, Japan, and SACU, and the near elimination of the U.S. sugar industry (-94% drop). Aggregate world sugar output and demand contracts by 1%. The final demand component of total sugar demand increases by 3% with large increases in all formerly protected countries (EU (47%), Japan (45%), the United States (27%), and SACU (22%)).

The world price increases by 21% which is close to the increase in the average import cost and average export unit value for key countries in the Armington version of the model,[4] but of course roughly 2.5 times the increase in the average sugar price variable (AWP) reached with the Armington version of the model. These comparisons are tenuous since the latter indices are weighted average of increases in bilateral-trade prices. Production increases strongly in Australia (192%), Thailand (99%), and CIS (200%) but less in Brazil. In the latter the change in producer price is less pronounced because there is a border distortion and the net producer price increase (world price increase net of the tariff removal) is moderate.

Sugar trade expands. The set of countries expanding trade is similar to the one obtained under the Armington version of the model. Formally protected markets exhibit higher import flows because the impact of the removal of the distortion net of the world price increase is beneficial in these countries. The EU increases its imports by 15 billion dollars, the United States by 4 billion dollars and Japan by 1.6 billion dollars. These figures are huge and illustrative of the large trade effects at work. The EU trade impact is probably larger than what one could realistically expect. Competitive exporters, Australia, Brazil, Rest of Latin and Central America, Thailand, increase their exports by 5, 1, 2.1, and 1.9 billion dollars respectively. The comparison of trade flows between the two versions of the model is tenuous because we are comparing net and gross trade flows.

**Welfare impact**

The welfare effects are qualitatively unchanged when compared to the Armington version of the model, although they are much larger in aggregate in the homogenous-good model. Aggregate welfare measured by EV increases by 13.6 billion dollars. Among exporters, major gains accrue to Australia-New Zealand (1.5 billion dollars), Brazil (0.7 billion dollars), Rest of Latin and Central America (1 billion dollars), and Thailand (0.7 billion dollars). Among major importers, the EU and Japan gain from the liberalization (5.5 and 1 billion dollars), and the United States loses (-1 billion dollars). This contrasting result among importers is explained as follows based on a decomposition of EV into a disposable income component and consumption price component.

[4] In the Armington version of the model, the import price would increase by 12 percent (EU), 36 percent (UNITED STATES), and 11 percent (Japan). The export unit price would increase substantially for major exporters. The range of increases is relatively wide expressing the variation of cost structures across countries and with an average increase of 15 percent for the key exporters included in the model.

The EU "devalues" (lower net factor income) by decreasing factor returns to enable large sugar imports (three times the level of U.S. imports) and benefits with lower domestic prices (sugar price via liberalization, and other sectors' prices via lower cost). Japan "appreciates" because of increased foreign demand for manufacturing good, raising the price of these goods. As a result Japanese domestic prices other than sugar increase and net income increases as well (appreciation). The sum of these effects is positive. The United States sees factor income increased (an appreciation) because of the stronger demand for its manufacturing good exports – Brazil and other exporters increase their imports of manufacturing goods. The United States has a large service sector, which can absorb higher factor prices and a resulting increase in service price. The latter sector has a large nontraded component. The net effect of lower sugar price, higher manufacturing prices, and service prices is negative for the United States.

Two asymmetries between the three countries explain their diverging fortunes following sugar trade liberalization. After trade liberalization the EU is a much larger importer than the United States and Japan. EU domestic production was more than twice as large as the U.S. production was and sugar import volume is just much larger for the EU than for the United States (3 times) or Japan (nearly 8 times). This explains why the EU experiences a devaluation via lower factor return. The United States and Japan have smaller sugar imports but have a different degree of trade opening. Japan's economy is a more open and manufacturing-intensive than the U.S. economy. This explains the appreciation is stronger in Japan than in the United States since manufacturing prices cannot rise as much as services prices which have a larger nontraded component.

The higher world price of sugar plays little role in the economic forces at work explaining the welfare effects in these three countries. The stronger the increase in world prices, the lower the welfare gains related to the trade liberalization via the sugar domestic price, but the logic of the necessary appreciation/depreciation and resulting decrease/increase in manufacturing and service prices remain unchanged. The treatment of sugar as a homogenous commodity (as opposed to an Armington structure) has little bearing on the qualitative results.

In this homogeneous-good version of the model we still get the discrepancy between the two welfare measures for the United States (real income at market prices and the equivalent variation). The discrepancy results from the different weighting of the various price effects and the way price and income effects are aggregated. In the EV decomposition, the price effects weighed by consumption expenditure shares are subtracted from the disposable income effect. In the real GDP measure, the numerator includes disposable income and trade, which is then deflated by a GDP deflator that aggregates the various price changes using weights not identical to expenditure shares. We note that in all cases, the aggregate welfare effects are small when expressed in percentage of disposable income (of the order of 0.06 percent for the globe).

**Table 1. Policy parameters setting by scenario (ad valorem tariffs (in percent) and quotas (in millions dollars of 1995))**

| Policy by country\scenario | baseline | EUQTA | EUTAR | EULIB | USQTA | USTAR | USLIB | JPQTA | JPTAR | JPLIB | QDQTA | QDTAR | QDLIB | MLTLT | FLLB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EU | | | | | | | | | | | | | | | |
| tariff in quota | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| tariff in-Brazil | 49 | 49 | 49 | 49 | 49 | 49 | 49 | 49 | 49 | 49 | 49 | 49 | 49 | 49 | **0** |
| tariff out of quota | 174 | 174 | **116** | **116** | 174 | 174 | 174 | 174 | 174 | 174 | 174 | **116** | **116** | **116** | **0** |
| aggregate quota | 971 | **1294** | 971 | **1294** | 971 | 971 | 971 | 971 | 971 | 971 | **1294** | 971 | **1294** | **1294** | **unrestricted** |
| | | | | | | | | | | | | | | | |
| USA | | | | | | | | | | | | | | | |
| tariff in quota | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| tariff out of quota except Mexico | 190 | 190 | 190 | 190 | 190 | 127 | 127 | 190 | 190 | 190 | 190 | 127 | 127 | 127 | **0** |
| tariff out of quota Mexico | 131 | 131 | 131 | 131 | 131 | **87** | **87** | 131 | 131 | 131 | 131 | **87** | **87** | **87** | 0 |
| aggregate quota | 898 | 898 | 898 | 898 | **1197** | 898 | **1197** | 898 | 898 | 898 | **1197** | 898 | **1197** | **1197** | **unrestricted** |
| | | | | | | | | | | | | | | | |
| Japan | | | | | | | | | | | | | | | |
| tariff out of quota | 155 | 155 | 155 | 155 | 155 | 155 | 155 | 155 | **103** | **103** | 155 | **103** | **103** | **103** | **0** |
| tariff in quota | 84 | 84 | 84 | 84 | 84 | 84 | 84 | 84 | 84 | 84 | 84 | 84 | 84 | 84 | **0** |
| aggregate quota | 409 | 409 | 409 | 409 | 409 | 409 | 409 | **546** | 409 | **546** | **546** | 409 | **546** | **546** | **unrestricted** |
| | | | | | | | | | | | | | | | |
| Other countries | | | | | | | | | | | | | | | |
| Tariffs | constant | constant | constant | constant | constant | constant | constant | constant | constant | constant | constant | constant | constant | 3% reductio | 100% reduction |

Aggregate quota for a country is the sum of sugar imports under quota reported in GTAP5 and aggregated over exporting countries in the country aggregation of LINKAGE 5.

**Table 2. Impact of sugar policy reforms on unit quota rents, out-of-quota imports, and total imports**

| Impact by country\scenario | baseline | EUQTA | EUTAR | EULIB | USQTA | USTAR | USLIB | JPQTA | JPTAR | JPLIB | QDQTA | QDTAR | QDLIB | MLTLT | FLLB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EU | | | | | | | | | | | | | | | |
| average unit rent (% of cif price) | 138 | 67 | 153 | 73 | 180 | 138 | 135 | 137 | 137 | 137 | 66 | 153 | 71 | 93 | 0 |
| out-quota imports (million dollars) | 0 | 0 | 110 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 109 | 0 | 0 | - |
| aggregate imports (million dollars)[1] | 3108 | 3491 | 3205 | 3491 | 3108 | 3108 | 3108 | 3108 | 3108 | 3108 | 3491 | 3204 | 3492 | 3614 | 6398 |
| change in aggregate imports (%) | | 12% | 3% | 12% | 0% | 0% | 0% | 0% | 0% | 0% | 12% | 3% | 12% | 16% | 106% |
| | 2137 | 2197 | 2234 | 2197 | 2138 | 2137 | 2138 | 2137 | 2137 | 2137 | 2197 | 2233 | 2198 | 2320 | |
| USA | | | | | | | | | | | | | | | |
| average unit rent (% of cif price) | 87 | 85 | 87 | 85 | 25 | 114 | 25 | 115 | 87 | 87 | 23 | 113 | 24 | 31 | 0 |
| out-quota imports (million dollars) | 4 | 4 | 4 | 4 | 0 | 8 | 0 | 4 | 4 | 4 | 0 | 8 | 0 | 0 | - |
| aggregate imports (million dollars) | 1092 | 1092 | 1092 | 1092 | 1451 | 1096 | 1451 | 1092 | 1092 | 1092 | 1451 | 1096 | 1451 | 1451 | 1829 |
| change in aggregate imports (%) | | 0% | 0% | 0% | 33% | 0% | 33% | 0% | 0% | 0% | 33% | 0% | 33% | 33% | 67% |
| Japan | | | | | | | | | | | | | | | |
| average unit rent (% of cif price) | 32 | 31 | 31 | 31 | 30 | 32 | 30 | 0 | 24 | 0 | 0 | 24 | 0 | 16 | 0 |
| out-quota imports (million dollars) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 34 | 0 | 0 | 33 | 0 | 0 | - |
| aggregate imports (million dollars) | 408 | 408 | 408 | 408 | 408 | 408 | 408 | 510 | 444 | 510 | 502 | 444 | 502 | 544 | 1079 |
| change in aggregate imports (%) | | 0% | 0% | 0% | 0% | 0% | 0% | 25% | 9% | 25% | 23% | 9% | 23% | 33% | 164% |

1. Figures Include intra-EU sugar trade.

**Table 3. Impact of reforms on aggregate sugar production by major countries (in million dollars of 1995)**

| | baseline (bau | EUQTA | EUTAR | EULIB | USQTA | USTAR | USLIB | JPQTA | JPTAR | JPLIB | QDQTA | QDTAR | QDLIB | MLTLT | FLLB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Producing countries | output level | change[1] | change | change | change | change | change | change | change | change | change | change | change | change | change |
| EU | 31001 | -2.48% | -0.66% | -2.48% | 0.07% | 0.00% | 0.07% | 0.02% | 0.01% | 0.02% | -2.37% | -0.65% | -2.38% | -1.46% | -9.09% |
| USA | 10222 | 0.09% | 0.02% | 0.09% | -9.68% | -0.11% | -9.68% | 0.02% | 0.01% | 0.02% | -9.56% | -0.08% | -9.54% | -9.28% | -14.60% |
| Japan | 5247 | 0.01% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | -7.54% | -2.74% | -7.54% | -6.96% | -2.70% | -6.95% | -9.82% | -39.16% |
| Canada | 273 | 0.90% | 0.26% | 0.90% | 4.91% | 0.00% | 4.91% | 0.44% | 0.16% | 0.44% | 6.09% | 0.41% | 6.09% | 5.94% | 14.57% |
| Australia-New Zealand | 3132 | 0.15% | 0.04% | 0.15% | 0.88% | 0.00% | 0.88% | 0.51% | 0.19% | 0.51% | 1.50% | 0.22% | 1.50% | 2.67% | 8.48% |
| Argentina | 3101 | 0.05% | 0.01% | 0.05% | 0.37% | 0.00% | 0.37% | 0.01% | 0.00% | 0.01% | 0.43% | 0.01% | 0.43% | 0.51% | 1.59% |
| Brazil | 15479 | 0.05% | 0.00% | 0.05% | 0.23% | 0.00% | 0.23% | 0.02% | 0.01% | 0.02% | 0.30% | 0.01% | 0.30% | 1.15% | 3.98% |
| China | 1622 | 0.23% | 0.06% | 0.23% | 0.38% | 0.00% | 0.38% | 0.17% | 0.05% | 0.17% | 0.77% | 0.11% | 0.77% | -1.02% | -1.41% |
| India | 20877 | 0.08% | 0.03% | 0.08% | 0.02% | 0.00% | 0.02% | 0.00% | 0.00% | 0.00% | 0.10% | 0.03% | 0.10% | 0.15% | 1.00% |
| Rest of Asia | 17684 | 0.20% | 0.05% | 0.20% | 0.23% | 0.00% | 0.23% | 0.16% | 0.06% | 0.16% | 0.60% | 0.11% | 0.60% | -0.06% | 1.00% |
| Rest of Central and Latin America | 8667 | 0.88% | 0.20% | 0.88% | 1.21% | 0.00% | 1.21% | 0.15% | 0.05% | 0.15% | 2.19% | 0.25% | 2.19% | 2.53% | 7.72% |
| East and Central Europe | 7919 | 0.00% | 0.00% | 0.00% | 0.16% | 0.00% | 0.16% | 0.02% | 0.01% | 0.02% | 0.17% | 0.01% | 0.17% | -2.66% | -10.82% |
| CIS | 1099 | 0.22% | 0.03% | 0.22% | 0.56% | 0.00% | 0.56% | 0.13% | 0.05% | 0.13% | 0.89% | 0.08% | 0.88% | 2.79% | 18.14% |
| MENA | 10325 | -0.53% | -0.14% | -0.53% | 0.16% | 0.00% | 0.16% | 0.04% | 0.01% | 0.04% | -0.33% | -0.13% | -0.33% | -2.17% | -7.93% |
| SACU | 998 | 2.66% | 0.60% | 2.66% | 0.80% | 0.00% | 0.80% | 0.68% | 0.24% | 0.68% | 3.89% | 0.78% | 3.89% | 1.55% | 12.80% |
| Rest of Sub-Saharan Africa | 4835 | 2.66% | 0.69% | 2.66% | 0.52% | 0.00% | 0.52% | 0.05% | 0.02% | 0.05% | 3.22% | 0.71% | 3.22% | 1.56% | 15.95% |
| Mexico | 5032 | 0.07% | 0.01% | 0.07% | 0.06% | 0.07% | 0.06% | 0.01% | 0.00% | 0.01% | 0.14% | 0.08% | 0.14% | 0.58% | 2.45% |
| Thailand | 2654 | 0.11% | 0.03% | 0.11% | 0.18% | 0.00% | 0.18% | 0.71% | 0.26% | 0.71% | 1.01% | 0.29% | 1.01% | 1.90% | 6.62% |
| Total | 150168 | -0.33% | -0.09% | -0.33% | -0.43% | 0.00% | -0.43% | -0.19% | -0.07% | -0.19% | -0.94% | -0.16% | -0.94% | -1.09% | -3.09% |

1. Changes are % difference from bau levels

**Table 4. Impact of reforms on aggregate sugar exports by exporting countries (in million dollars of 1995)**

| | baseline (bau | EUQTA | EUTAR | EULIB | USQTA | USTAR | USLIB | JPQTA | JPTAR | JPLIB | QDQTA | QDTAR | QDLIB | MLTLT | FLLB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Exporting Countries | export level | change[1] | change | change | change | change | change | change | change | change | change | change | change | change | change |
| Australia New Zealand | 634 | 0.61% | 0.15% | 0.61% | 3.48% | 0.00% | 3.48% | 1.99% | 0.73% | 1.99% | 5.93% | 0.88% | 5.93% | 10.67% | 34.15% |
| Argentina | 69 | 2.16% | 0.49% | 2.16% | 15.42% | 0.00% | 15.42% | 0.36% | 0.13% | 0.36% | 17.91% | 0.60% | 17.91% | 26.37% | 86.58% |
| Brazil | 1452 | 0.47% | 0.00% | 0.47% | 2.20% | 0.00% | 2.20% | 0.21% | 0.07% | 0.21% | 2.88% | 0.08% | 2.87% | 10.91% | 38.01% |
| India | 222 | 10.71% | 4.45% | 10.71% | 2.32% | 0.00% | 2.32% | 0.14% | 0.02% | 0.14% | 13.20% | 4.49% | 13.20% | 27.99% | 166.37% |
| Rest of Asia | 531 | 9.41% | 2.51% | 9.41% | 6.89% | 0.00% | 6.89% | 1.01% | 0.23% | 1.01% | 17.35% | 2.70% | 17.35% | 24.18% | 145.25% |
| Rest of Latin and Central America | 1991 | 4.67% | 1.08% | 4.67% | 6.98% | 0.00% | 6.98% | 0.77% | 0.27% | 0.77% | 12.22% | 1.32% | 12.22% | 19.32% | 63.42% |
| Eastern and Central Europe | 315 | 6.40% | 1.80% | 6.40% | 1.70% | 0.00% | 1.70% | 0.18% | 0.09% | 0.18% | 8.27% | 1.89% | 8.27% | 42.38% | 365.59% |
| CIS | 265 | 0.79% | 0.13% | 0.79% | 0.47% | 0.00% | 0.47% | 0.09% | 0.03% | 0.09% | 1.33% | 0.16% | 1.32% | 24.43% | 154.81% |
| MENA | 97 | 10.65% | 2.85% | 10.65% | 3.25% | 0.00% | 3.25% | 2.30% | 0.72% | 2.30% | 16.58% | 3.62% | 16.58% | 28.76% | 222.93% |
| SACU | 311 | 9.28% | 2.05% | 9.28% | 2.79% | 0.00% | 2.79% | 2.47% | 0.89% | 2.47% | 13.71% | 2.73% | 13.71% | 31.41% | 165.93% |
| Rest of Sub-Saharan Africa | 608 | 25.72% | 6.73% | 25.72% | 3.35% | 0.00% | 3.35% | 0.10% | 0.03% | 0.10% | 29.15% | 6.77% | 29.15% | 34.16% | 232.26% |
| Mexico | 148 | 1.88% | 0.36% | 1.88% | 4.76% | 2.21% | 4.76% | 0.22% | 0.08% | 0.22% | 6.90% | 2.63% | 6.89% | 22.13% | 87.33% |
| Thailand | 903 | 0.27% | 0.06% | 0.27% | 0.43% | 0.00% | 0.43% | 1.71% | 0.63% | 1.71% | 2.44% | 0.70% | 2.44% | 4.58% | 15.99% |
| Total for above exporters | 7545 | 5.33% | 1.37% | 5.33% | 3.91% | 0.04% | 3.91% | 0.85% | 0.30% | 0.85% | 9.99% | 1.69% | 9.99% | 18.88% | 95.54% |

1. Changes are percent differences from bau levels

**Table 5. Impact of sugar trade reforms on real GDP at base market prices (in million of dollars of 1995)**

| Countries\sc | EUQTA | EUTAR | EULIB | USQTA | USTAR | USLIB | JPQTA | JPTAR | JPLIB | QDQTA | QDTAR | QDLIB | MLTLT | FLLB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EU | 349 | 98 | 349 | -7 | 0 | -7 | -2 | -1 | -2 | 338 | 96 | 339 | 285 | 1096 |
| USA | -1 | 0 | -1 | 206 | 3 | 206 | 0 | 0 | 0 | 206 | 3 | 206 | 207 | 324 |
| Japan | 1 | 0 | 1 | -1 | 0 | -1 | 111 | 43 | 111 | 103 | 43 | 103 | 141 | 338 |
| Canada | 0 | 0 | 0 | -3 | 0 | -3 | 0 | 0 | 0 | -3 | 0 | -3 | -4 | -12 |
| Australia-N | 0 | 0 | 0 | -4 | 0 | -4 | 0 | 0 | 0 | -4 | 0 | -4 | -4 | -13 |
| Argentina | 0 | 0 | 0 | -2 | 0 | -2 | 0 | 0 | 0 | -1 | 0 | -1 | -2 | -6 |
| Brazil | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 3 | 0 | 3 | 31 | 110 |
| China | -1 | 0 | -1 | -2 | 0 | -2 | -1 | 0 | -1 | -4 | -1 | -4 | 8 | 11 |
| India | -5 | -2 | -5 | 0 | 0 | 0 | 0 | 0 | 0 | -5 | -2 | -5 | 0 | -33 |
| Rest of Asia | -10 | -3 | -10 | -5 | 0 | -5 | 0 | 0 | 0 | -16 | -3 | -16 | 2 | -96 |
| Rest of Cen | -25 | -6 | -25 | -14 | 0 | -14 | 2 | 1 | 2 | -39 | -5 | -39 | -19 | -131 |
| East and Ce | 1 | 0 | 1 | -2 | 0 | -2 | 0 | 0 | 0 | -1 | 0 | -1 | 119 | 308 |
| CIS | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 2 | 14 | 4 |
| MENA | 0 | 0 | 0 | -1 | 0 | -1 | 0 | 0 | 0 | -1 | 0 | -1 | 5 | -72 |
| SACU | -6 | -1 | -6 | -1 | 0 | -1 | 1 | 0 | 1 | -5 | -1 | -5 | 31 | 51 |
| Rest of Sub- | -29 | -7 | -29 | -3 | 0 | -3 | 0 | 0 | 0 | -32 | -7 | -32 | -19 | -284 |
| Mexico | -1 | 0 | -1 | -2 | -2 | -2 | 0 | 0 | 0 | -2 | -2 | -2 | -2 | -8 |
| Thailand | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 2 | 2 | 1 | 2 | 4 | 14 |
| Total | 276 | 80 | 276 | 160 | 2 | 160 | 114 | 44 | 114 | 539 | 125 | 540 | 796 | 1602 |

**Table 6. Impact of sugar trade reforms on welfare (EV measures in million 1995 dollars)**

| Countries\S | EUQTA | EUTAR | EULIB | USQTA | USTAR | USLIB | JPQTA | JPTAR | JPLIB | QDQTA | QDTAR | QDLIB | MLTLT | FLLB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EU | 227 | 64 | 227 | -16 | 0 | -16 | -6 | -2 | -6 | 200 | 62 | 201 | 192 | -352 |
| USA | -13 | -3 | -13 | 80 | 1 | 80 | -3 | -1 | -3 | 60 | -3 | 60 | 63 | -78 |
| Japan | 2 | 1 | 2 | 1 | 0 | 1 | 216 | 85 | 216 | 202 | 85 | 202 | 279 | 614 |
| Canada | 3 | 1 | 3 | 15 | 0 | 15 | -1 | 0 | -1 | 17 | 1 | 17 | 12 | 25 |
| Australia-N | 3 | 1 | 3 | 9 | 0 | 9 | 5 | 2 | 5 | 16 | 2 | 16 | 26 | 105 |
| Argentina | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | -1 |
| Brazil | 5 | 0 | 5 | 24 | 0 | 24 | 2 | 1 | 2 | 31 | 1 | 31 | 100 | 377 |
| China | -1 | 0 | -1 | -7 | 0 | -7 | -1 | 0 | -1 | -9 | 0 | -9 | 13 | 16 |
| India | 2 | 1 | 2 | 0 | 0 | 0 | -1 | 0 | -1 | 1 | 1 | 1 | 8 | 32 |
| Rest of Asia | 16 | 5 | 16 | -3 | 0 | -3 | -12 | -4 | -12 | 1 | 0 | 1 | 27 | 94 |
| Rest of Cen | 52 | 12 | 52 | 87 | 0 | 87 | 9 | 3 | 9 | 149 | 15 | 149 | 189 | 643 |
| East and Ce | 19 | 5 | 19 | -1 | 0 | -1 | -1 | 0 | -1 | 17 | 5 | 17 | 136 | 369 |
| CIS | 7 | 2 | 7 | -8 | 0 | -8 | -2 | -1 | -2 | -2 | 2 | -2 | 20 | 138 |
| MENA | 57 | 15 | 57 | -5 | 0 | -5 | 0 | 0 | 0 | 52 | 15 | 52 | 53 | 245 |
| SACU | 11 | 2 | 11 | 3 | 0 | 3 | 3 | 1 | 3 | 16 | 3 | 16 | 56 | 214 |
| Rest of Sub- | 50 | 13 | 50 | 4 | 0 | 4 | 0 | 0 | 0 | 54 | 13 | 54 | 47 | 338 |
| Mexico | 2 | 0 | 2 | 7 | 0 | 7 | 0 | 0 | 0 | 9 | 0 | 9 | 5 | 10 |
| Thailand | 2 | 1 | 2 | 3 | 0 | 3 | 14 | 5 | 14 | 19 | 6 | 19 | 38 | 157 |
| Total | 443 | 121 | 443 | 194 | 1 | 194 | 222 | 87 | 222 | 836 | 207 | 837 | 1265 | 2948 |

**Table 7. Impact of sugar trade reforms on import and export prices (percent deviation from baseline)[1]**

| Countries\Scenarios | EUQTA | EUTAR | EULIB | USQTA | USTAR | USLIB | JPQTA | JPTAR | JPLIB | QDQTA | QDTAR | QDLIB | MLTLT | FLLB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EU | 2.76% | 2.30% | 2.76% | 0.46% | 0.00% | 0.46% | 0.11% | 0.04% | 0.11% | 3.31% | 2.33% | 3.33% | 3.07% | 11.56% |
| USA | 1.23% | 0.28% | 1.23% | 15.91% | 0.51% | 15.91% | 0.35% | 0.12% | 0.35% | 17.51% | 0.91% | 17.50% | 17.88% | 36.46% |
| Japan | 0.45% | 0.10% | 0.45% | 0.60% | 0.00% | 0.60% | 0.80% | 0.29% | 0.80% | 1.86% | 0.39% | 1.86% | 2.66% | 10.62% |
| Australia-New Zealand | 0.22% | 0.07% | 0.22% | 2.36% | 0.01% | 2.36% | 0.58% | 0.21% | 0.58% | 3.14% | 0.29% | 3.14% | 4.55% | 13.34% |
| Argentina | 0.17% | 0.04% | 0.17% | 6.26% | 0.04% | 6.26% | 0.03% | 0.01% | 0.03% | 6.47% | 0.08% | 6.47% | 6.69% | 14.47% |
| Brazil | 0.29% | 0.02% | 0.29% | 1.32% | 0.01% | 1.32% | 0.03% | 0.01% | 0.03% | 1.65% | 0.04% | 1.65% | 2.85% | 8.57% |
| India | 3.15% | 3.10% | 3.15% | 0.53% | 0.00% | 0.53% | 0.00% | 0.00% | 0.00% | 3.68% | 3.11% | 3.68% | 3.51% | 14.20% |
| Rest of Asia | 2.77% | 1.81% | 2.77% | 2.75% | 0.02% | 2.75% | 0.28% | 0.10% | 0.28% | 5.81% | 1.91% | 5.81% | 4.39% | 15.06% |
| Rest of Central and Latin America | 3.03% | 1.30% | 3.03% | 5.38% | 0.03% | 5.38% | 0.25% | 0.09% | 0.25% | 8.66% | 1.39% | 8.66% | 9.10% | 24.76% |
| East and Central Europe | 1.48% | 1.12% | 1.48% | 0.45% | 0.00% | 0.45% | 0.02% | 0.01% | 0.02% | 1.95% | 1.13% | 1.95% | -1.14% | -3.66% |
| CIS | 0.38% | 0.15% | 0.38% | 0.48% | 0.00% | 0.48% | 0.10% | 0.03% | 0.10% | 0.94% | 0.18% | 0.94% | 1.27% | 9.40% |
| MENA | 2.14% | 1.68% | 2.14% | 1.03% | 0.01% | 1.03% | 0.02% | 0.01% | 0.02% | 3.19% | 1.70% | 3.19% | 1.61% | 6.95% |
| SACU | 5.43% | 2.19% | 5.43% | 1.86% | 0.01% | 1.86% | 0.68% | 0.25% | 0.68% | 7.85% | 2.34% | 7.85% | 4.21% | 21.76% |
| Rest of Sub-Saharan Africa | 8.77% | 5.35% | 8.77% | 1.60% | 0.01% | 1.60% | 0.02% | 0.01% | 0.02% | 10.40% | 5.37% | 10.41% | 8.32% | 37.67% |
| Mexico | 0.71% | 0.33% | 0.71% | 3.63% | 2.72% | 3.63% | 0.02% | 0.01% | 0.02% | 4.40% | 3.04% | 4.39% | 5.68% | 17.20% |
| Thailand | 0.28% | 0.08% | 0.28% | 0.49% | 0.00% | 0.49% | 1.36% | 0.50% | 1.36% | 2.17% | 0.58% | 2.17% | 3.96% | 15.07% |

[1]for importing counrtries (EU, USA, Japan) the price is the average import unit cost before tariff at the border. For the other countries the price is an average export unit price at the border.