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Agricultural trade restrictiveness in the European Union and the United States

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Abstract

The article provides a summary measure of the Uruguay Round tariff reduction commitments in the European Union and the United States, using the Mercantilistic Trade Restrictiveness Index (MTRI) as the tariff aggregator. We compute the index for agricultural commodity aggregates assuming a specific (constant elasticity of substitution) functional form for import demand. The levels of the MTRI under the actual commitments of the Uruguay Round are computed and compared with two hypothetical cases, a deeper cut in higher tariffs and a uniform reduction of each tariff, both leading to the same average reduction as in the Uruguay Round. This makes it possible to infer how reducing tariff dispersion will help improve market access in future trade agreements, and provides some guidelines for aggregating detailed tariffs in trade models.

JEL classification: F13, Q17

Keywords: International agricultural trade; Protection; Tariffs and tariff factors

1. Introduction

One major achievement of the Uruguay Round Agreement on Agriculture (URAA) was the prohibition of quantitative barriers to agricultural trade, requiring that all such trade take place under a tariff-only regime (except for some specific derogations including tariff quotas). Each World Trade Organization (WTO) member established a base schedule, containing both pre-existing and new tariffs resulting from the conversion of nontariff measures, following an international commodity classification scheme (referred to as the *Harmonised System* or HS).

The adoption of a tariffs-only approach for agriculture was a sweeping reform that went a long way toward subjecting agricultural trade to the same disciplines applied to other traded goods. However, many authors have pointed out that the URAA agreement achieved only minor reductions in protection (Tangermann, 1995). One reason for this conclusion is the rather lax method of conversion of nontariff measures into their tariff equivalents. It has also often been pointed out that member countries were allowed significant flexibility in the allocation of tariff cuts. For instance, the tariff cutting formula was based on a simple average. Thus, by making rather large percentage cuts in low tariffs, or in tariffs for commodities that do not compete with domestic production, countries could meet the overall 36% average objective with only minimal cuts in politically sensitive tariffs. The present negotiations under the so-called *Doha Development Agenda* raise concerns that similar dilution of the commitments may occur. For that reason, a number of countries have proposed measures to ensure substantial improvements in market access, using for example, a "Swiss Formula," under which the size of tariff cut is an increasing function of the level of the initial tariff. The July 31, 2004 Council Decision of the WTO states that "progressivity in tariff reduction will be achieved through deeper cuts in higher tariffs with flexibilities for sensitive products" (WTO, 2004). Even though the practical modalities of these cuts are still a matter of negotiation, it is foreseen that a system of bands with different thresholds will be used. Simulations show that such a system results in a tariff structure that is very close to the one obtained by the Swiss Formula. There is some uncertainty, though, about the actual effect of such "harmonizing" formulas on market openness, compared to commitments based on a radial cut (i.e., all tariff lines cut by the same percentage), or on an average cut as implemented in the URAA. This is one of the issues addressed in this article.

All studies on market access run into some major difficulties linked to data availability and international inconsistencies in

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classifications. These empirical aspects are perhaps the main reason why the various studies differ so much when measuring the degree of market access in a given country.[1] However, methodological issues are also important. To assess the overall effect of an uneven reduction in a large number of tariffs, one faces the problem of finding the appropriate index. Recent developments in the theory of index numbers have led to new indicators of the aggregate impact of trade policy, such as the *Trade Restrictiveness Index* (TRI) and the *Mercantilistic Trade Restrictiveness Index* (MTRI). The MTRI, introduced by Anderson and Neary (2003), consists in estimating the uniform tariff that yields the same aggregate volume of imports as the original vector of (nonuniform) tariffs across a number of imports. We believe that using the trade volume as the reference standard is appropriate in the context of trade negotiations, since countries involved in the negotiation are interested in the trade volume displacement due to changes in tariffs. Indeed, one of the pillars of the WTO is the "principle of reciprocity" that can be interpreted as equivalent import volume expansion (see Bagwell and Staiger, 2000). Our contribution is as follows:

- First, assuming a specific functional form for the import demand, we address the problem of assessing the tariff reduction commitments undertaken by the European Union (EU) and the United States (US) under the URAA. In order to do so, we compute the MTRI in 1995 (the first year of the implementation of the URAA) and in 2001 (the end of the implementation period) for 20 agricultural commodity aggregates.
- Second, we compare the effect of the URAA on tariffs with an alternative tariff reduction scheme whereby high tariffs are cut more dramatically than low tariffs.
- Third, we measure the magnitude of the "dilution effect" that could have resulted from the distribution of large and minimal cuts across tariff lines. This is done by comparing the URAA tariff cuts with a uniform (i.e., radial) reduction in tariffs.
- Fourth, we compare an index based on economic theory, such as the MTRI, to other a-theoretic, *ad hoc* indexes of tariff reductions, such as the simple arithmetic average of tariff cuts adopted in the URAA. Our contention is that much of the empirical evidence based on these indexes is inherently flawed.
- Finally, we compute the level of MTRI and not simply the relative rates of change between two points in time as in Bureau et al., (2000), hereafter BFS. Our results provide a measure of the overall level of protection across countries, both before and after the URAA.

Computing MTRI levels using a computable general equilibrium (CGE) model does not allow the degree of detail sufficient to work with the actual commitments on agricultural tariffs. Here, we construct an approximation of the MTRI that makes it possible to handle the present EU and US tariff structure, e.g., some 1,500 tariff lines in agriculture. Our results provide indicators of the degree of market access for 20 aggregated agricultural products, which are consistent with a dataset widely used by trade practitioners, the GTAP dataset (Hertel, 1997).

2. Methodology

The practical and theoretical deficiencies of traditional tariff indexes, such as the simple or the trade-weighted average tariff, are well known (Anderson and Neary, 2003; Laird and Yeats, 1988). Indexes such as the TRI and the MTRI have more solid theoretical foundations, although the definition of such indexes relies on several restrictive assumptions, including the existence of a competitive equilibrium, a single representative consumer, and fixed world prices (i.e., the small country assumption). Because they are derived from the balance of trade function, the TRI and the MTRI synthesize the overall effect of trade policy on the economy.[2]

The assumption of fixed (exogenous) world prices is questionable, since our empirical analysis deals with US and EU, the two major traders on the world agricultural market. However, the small country assumption helps to guarantee the existence and uniqueness of the indexes, ruling out counterintuitive "second best" results, and it is consistent with a *ceteris paribus* approach (Bureau and Salvatici, 2004).[3]

The most theoretically consistent solution would be to compute the MTRI as the (scalar) tariff that would yield the same volume of imports as the initial tariff structure using a CGE model (Anderson and Neary, 2003). However, the limitations in the number of commodities in CGE models require a substantial aggregation of trade flows and tariffs.[4] Agricultural tariffs vary widely even within a single product aggregate (e.g., within a single chapter of the HS classification). In addition, tariff reductions under the URAA were taken on the basis of a very detailed list of items, and the magnitude of tariff cut also varies substantially within a product category (Gibson et al., 2001). Therefore, a significant amount of information on the level of tariff dispersion (and on the change in dispersion over time) is lost when aggregating tariffs data up to the level that

[1] For example, estimates of the EU average agricultural tariff for agriculture after the Uruguay Round range between less than 9.7% (Gallezot, 2002) and 40% (Messerlin, 2001).

[2] The balance of trade function summarizes the outcome of both private and public behavior. Equilibrium of the economy is consistent with a balance of trade that equals an exogenous income. Anderson and Neary (1996) and Martin (1997) provide detailed insights on the use of the balance-of-trade function.

[3] Anderson and Neary (2003), argue (footnote 8) that "there is a rationale for a *ceteris paribus* trade restrictiveness index that fixes world prices even when these prices are in fact endogenous." Such a rationale may be represented by the fact that, by keeping world prices constant, we focus on the component of protection explained by national policies, and not by the degree of market power of the country.

[4] Anderson and Neary (2003) use Anderson's (1998) CGE model which is unusually disaggregated as far as the trade structure is concerned. However, even this model relies on a 4-digit HS classification, while the official WTO tariff commitments of the EU and the US in the food and agricultural sector specify tariffs at the 8-digit level.

is consistent with CGE models aggregate. In order to be able to take into account the impact of changes occurring on a very large number of finely differentiated tariff lines, we build on the insights of Bach and Martin (2001) who assume a specific functional for import demand. Their methodology, which aims to develop tariff aggregators for both the expenditure and tariff revenue components of CGE models, can be adapted in order to compute the MTRI.

2.1. Mercantilistic trade restrictiveness index

Our starting point is the trade behavior of an economy under perfect competition. When tariffs are imposed, government behavior in collecting tariff revenues and redistributing them in lump-sum fashion needs to be incorporated in the representation of the economy. Both government and private behaviors are summarized by the balance of trade (BoT) function $B\ (p, u, z)$. The BoT represents the external budget constraint, and is equal to the net transfer required to reach a given level of aggregate domestic welfare u, for a given set of domestic prices p, and factor endowments vector z. It summarizes the three possible sources of funds for procuring imports: earnings from exports, earnings from tariff revenues, and international transfers (Anderson and Neary, 2003). The MTRI relies on the idea of evaluating trade policy using trade volume as the reference standard. The MTRI is defined in terms of the uniform tariff τ that yields the same volume (at world prices) of tariff-restricted imports as the initial vector of (nonuniform) tariffs. This can be expressed with import demand functions M, while holding constant the balance of trade function at level B^0;

$$\tau : M[(1+\tau)p^*, B^0] = M^0, \tag{1}$$

where p^* denotes the international price vector of the N goods $k = (1, \ldots, N)$ and M^0 is the value of aggregate imports (at world prices) in the reference period. Define the scalar import demand as

$$M(p, p^*, B) \equiv \sum_{k=1}^{N} p_k^* I_k^{\mathrm{m}}, \tag{2}$$

where I^{m} denotes the uncompensated (Marshallian) import demand function and p is the domestic price vector. Accordingly, the MTRI uniform tariff τ would lead to the same volume of imports (at world prices) as the one resulting from the uneven tariff structure denoted by the N-dimensional tariff vector t whose elements are t_k. That is, the MTRI can be computed by solving Eq. (3) for τ.[5]

$$\sum_{k=1}^{N} p_k^* I_k^{\mathrm{m}}\left[p^*(1+\tau), B^0\right] = \sum_{k=1}^{N} p_k^* I_k^{\mathrm{m}}\left[p^*(1+t_k), B^0\right]. \tag{3}$$

[5] The MTRI derived from equation (3) provides a measure of trade restrictiveness relative to a free trade reference, while BFS computed a "uniform tariff surcharge" measuring changes in the tariff structure from the initial equilibrium to the new (still distorted) equilibrium.

2.2. Empirical estimation of the MTRI

Having defined the MTRI, for the empirical implementation we follow Bach and Martin (2001) modeling demand through a constant elasticity of substitution (CES) functional form. This function imposes well-known restrictive assumptions on separability. Nonetheless it has several empirical advantages that explain its use in modeling import demand (Winters, 1984). If the utility function is homogeneously separable, commodities may be consistently aggregated (Gorman, 1959). That is, one may form composite commodities which may be treated in the same manner as the primary commodities. Accordingly, we assume that the overall basket of goods can be partitioned into J aggregates denoted $j = 1, \ldots, J$, and the utility function of the representative consumer can be written as

$$U = \phi(u_1(x_1), \ldots, u_J(x_J)), \tag{4}$$

where ϕ is continuous, twice differentiable, and strictly quasi concave, and u_i are continuous, twice differentiable functions, homogeneous of degree 1 (Lloyd, 1975). When focusing on the J sectoral MTRIs, a convenient (albeit restrictive) assumption is to assume ϕ to be a Cobb-Douglas function (implying that the expenditure function is also a Cobb-Douglas one in prices with utility entering multiplicatively). In such a case, we avoid the issue of allocation of consumer expenditure across sectors which, in general equilibrium models, is affected by tariffs within a particular aggregate j (Bureau and Salvatici, 2004).

In our application, we assume that u_j is a CES function in x_j. Since the import volume function is homogenous of degree zero in the prices of traded goods, the MTRI cannot be calculated (any uniform tax would be equivalent to free trade in terms of imports).[6] This difficulty of evaluating the MTRI can be circumvented if (i) there is a designated "reference good" so that the price vectors refer to prices relative to this good; or (ii) we use the price of the least distorted imported good in each sector as the *numéraire*, avoiding the need to include the domestic good in the subexpenditure function. Since there are some sectors (such as dairy, sugar, and beef in the EU, for example) in which all products face strictly positive tariffs, using the least distorted good in each sector as the reference would not allow to draw meaningful comparisons across sectors and/or countries. We use the popular Armington (1969) assumption that imports are imperfect substitutes for domestic goods, and we solve the problem by taking the domestic good as the *numéraire* (Bach and Martin, 2001).[7] We partition the consumption vector x_j within the jth group into an aggregated domestic good denoted

[6] More generally, Neary (1998) shows how the failure to select a reference untaxed good leads to misleading results in the theory of trade policy.

[7] The assumption that the domestic good is *numéraire* does not imply that it is exogenous. However, endogeneity would require specifying market clearing to allow price determination. Here, our goal is to develop a methodology allowing the computation of tariff aggregators without using a CGE model.

with a suffix d and $N_j - 1$ traded goods denoted with an index i

$$u_j = \left(\beta_{dj}(x_{dj})^{\rho j} + \sum_i \beta_{ij}(x_{ij})^{\rho j}\right)^{\frac{1}{\rho j}}. \quad i = 1, \ldots, N_j \tag{5}$$

Denoting $\sigma_j = \frac{1}{1-\rho_j}$ (the elasticity of substitution within the j group), the expenditure devoted to each aggregate j is

$$e_j(p, u) = \left(\beta_{dj}(p_{dj})^{1-\sigma_j} + \sum_i \beta_{ij}(p_{ij})^{1-\sigma_j}\right)^{\frac{1}{1-\sigma_j}} u_j. \tag{6}$$

The parameters β_{ij} can be calibrated to the initial values of the expenditure shares in the base data, when all domestic prices are set to 1. After deriving the indirect utility function by inverting Eq. (6), the Marshallian demand functions of each of the $i = 1, \ldots, N_j - 1$ imported goods can be found by Roy's identity

$$x_{ij} = \beta_{ij} \frac{p_{ij}^{-\sigma_j}}{\left(\beta_{dj}(p_{dj})^{1-\sigma_j} + \sum_i \beta_{ij}(p_{ij})^{1-\sigma_j}\right)} e_j. \tag{7}$$

Denoting P_j as the price index that corresponds to the denominator of the right-hand side, the import volume function for the jth aggregate, valued at world prices, is

$$\sum_{i=1}^{N^j} p_{ij}^* x_{ij} = \sum_i p_{ij}^* \beta_{ij} \left(\frac{1}{P_j \times p_{ij}^{\sigma_j}}\right) e_j \text{ with } i = 1, \ldots, N_{j-1}. \tag{8}$$

When the initial total expenditure e_j^0 (expenditures on both domestic and imports in j) is used in Eq. (8), we obtain the demand function at the initial level of imports.

The MTRI uniform tariff equivalent τ_j for each aggregate j is found by setting the value of the import volume function with the uniform tariff equivalent equal to the initial value of imports (evaluated at world prices):

$$\sum_i p_{ij}^* \beta_{ij} \left(\frac{P_j^\tau}{p_{ij}^*(1+\tau_j)}\right)^{\sigma_j} e_j^0 = \sum_i p_{ij}^* I_{ij}^0, \tag{9}$$

where I_{ij}^0 are the volumes of imports in the initial period (i.e., 1995 or 2001 in our numerical applications), and P_j^τ is the price index

$$P_j^\tau = \left(\beta_{dj}(p_{dj})^{1-\sigma_j} + \sum\nolimits_i \beta_{ij}(p_{ij}^*(1+\tau_j))^{1-\sigma_j}\right)^{-\sigma_j}. \tag{10}$$

The uniform tariff equivalents for each aggregate commodity j are found using an optimization routine in the GAMS package (Brooke et al., 1998), solving for τ_j in equations (9) and (10).

The indicators τ_j are by themselves relevant for the analysis of trade policy. In addition, τ_j can be used as aggregate tariffs in any trade model with a commodity aggregation and an import demand structure which is consistent with our assumptions. However, it must be acknowledged that they are only an approximation of the "true" (i.e., general equilibrium) MTRI tariff equivalent, since using initial total expenditure e_j^0 in Eq. (9) we ignore the income effect due to the change in tariff revenue. In our application, dealing with products that are characterized by low-income elasticities in developed countries, we do not expect this to be a significant issue.[8]

One may expect that the computation of an *aggregate* (i.e., for the whole agricultural sector) MTRI tariff equivalent could be easily performed by introducing an upper-level demand system. However, the requirement of a reference untaxed good for the computation of the MTRI tariff aggregator makes the computation of the same index at different levels of aggregation a tricky issue. As a matter of fact, if the *numéraire* is a domestic good, the price (and quantity) index to be used at the upper level would include *both* domestic and imported goods, and this would make the computation of an upper-level tariff aggregator meaningless. As a consequence, in order to compute an MTRI tariff equivalent for the entire dataset, we define it as the uniform tariff τ that would keep the overall (i.e., on all $j = 1, \ldots, J$ sectors) import volume equal to the initial value. This can be obtained by modifying Eq. (9) as follows:

$$\sum_j \sum_i p_{ij}^* \beta_{ij} \times \left(\frac{\left(\beta_{dj}(p_{dj})^{1-\sigma_j} + \sum_i \beta_{ij}(p_{ij}^*(1+\tau))^{1-\sigma_j}\right)^{-\sigma_j}}{p_{ij}^*(1+\tau)}\right)^{\sigma_j} \times e_j^0 = \sum_j \sum_i p_{ij}^* I_{ij}^0. \tag{11}$$

2.3. Dataset

The volumes of imports are taken directly from the respective U.S. and EU datasets (US International Trade Commission and Eurostat's Comext data). The Schedule XX that the EU and the U.S. submitted to the WTO provides the base and bound tariffs at the 8-digit level of the HS classification. The URAA schedule therefore provides information on tariffs in 1995 (that is, after the Uruguay Round tariffication process) and in 2001 and onward (that is, after the implementation of the mandatory 36% average reduction in tariffs). The domestic prices are constructed by multiplying the world price p^* by the *ad valorem* tariff structure (initial, final, or counterfactual tariffs) that we are interested in. As a result, the measure of market access focuses only on changes in the tariffs *ceteris paribus*, and is

[8] Beghin et al. (2003) introduce the full expansion effects consistent with general equilibrium in their sectoral MTRI, but the impact on their empirical results is very limited.

not affected by exogenous price variations (see BFS, 2000 for details on the dataset).

In this article, the focus of the analysis is on the tariff reduction commitments. We ignore tariff rate quotas. The EU tariff schedule includes 1,764 tariff lines, while the US schedule includes 1,377 tariff lines (excluding in quota tariffs). Both the EU and the U.S. apply their bound tariffs on products traded in a most favored nation (MFN) framework. That is, using the URAA schedules gives a good image of the actual tariff structure, although lower tariffs are applied in the framework of preferential agreements that we did not consider here. For purposes of calculation, we converted specific tariffs into *ad valorem* equivalents, following the same conventions as in BFS (2000).

The elasticities of substitution σ_j that match the list of aggregates are taken from the GTAP dataset (Dimaranan and McDougall, 2002). This comprehensive dataset is widely used in applied analysis, and researchers might be interested in tariff aggregates that match the GTAP classification for simulation purposes. Moreover, the conversion tables from detailed tariff structures to the GTAP sectors are fully available, which makes it possible to aggregate the very detailed list of tariffs of the URAA schedule into a restricted number of products that correspond to the GTAP system of classification. Finally, the dataset provides the information that is necessary for distinguishing between expenditures on domestic products and imports. There is however little justification for using the GTAP elasticities. It actually is quite bothersome that these elasticities are the same for the EU and the U.S. (Table 1). However, providing new estimates is certainly beyond the scope of this work. We undertook sensitivity tests to examine the effects of different elasticity values on the measurement of MTRI uniform tariffs: the results are presented in Section 6.

The original GTAP dataset distinguishes $J = 20$ agricultural and food aggregate products. In order to include nonfood commodities listed in the URAA schedules (mainly agricultural goods listed in Chapters 29–53 of the HS classification) we defined an extra aggregate. We ignore one GTAP sector (raw milk) because there is no trade for the corresponding commodity. Overall, we aggregated 1,764 tariff lines in the EU (1,377 tariff lines in the US) at the 8-digit level of the HS classification up to 20 aggregate products described in Table 1. It is noteworthy that the number of tariff lines in each commodity aggregate is very uneven. Table 1 shows, for example, that there are only three tariff lines in the aggregate "paddy rice," while the aggregate "fruits and vegetables" tariff includes 183 tariff lines in the EU schedule.

3. Measures of market access prior to the Uruguay Round agreement

The computation of the MTRI uniform tariff equivalent τ_j provides an estimate of the trade restrictiveness of the actual tariff structure. It is calculated for the year 1995 for both the EU and the U.S., making it possible to compare the trade effect of the tariff structures prior to implementation of the Uruguay Round commitments.

The structure of bound tariffs in the EU and the U.S. differs in several aspects (Table 2). The average nonweighted base tariff was 9.7% (12.7% if we consider only the items with nonzero tariffs) in the U.S., while in the EU the average tariffs were 26.7% (31.4%, respectively). In most sectors, the EU average tariff is larger than the U.S. average tariff, the gap being particularly wide in the grains, meat, sugar, and rice sectors. In the EU, the trade-weighted average tariff is usually larger than the nonweighted average, while it is generally the opposite in the U.S. A trade-weighted average tariff that is smaller than the nonweighted one can result from prohibitive tariffs or may simply mean that larger tariffs are set on commodities whose demand is particularly elastic. Here, there is evidence that very high tariffs are set in a few sectors where the government is willing to protect domestic producers from imports, as in the U.S. groundnut or dairy sectors. On the other hand, the trade-weighted average is larger than the nonweighted average tariff when low tariffs are set on products whose demand is structurally limited, either because these are niche market products (e.g., processed products, peculiar types of fruits, beverages, and condiments in the EU), or because local producers are competitive (e.g., pig meat and poultry meat). This may also mean that higher tariffs are set on goods with a relatively inelastic demand for imports.

4. Comparison between the MTRI and a-theoretic indicators

Table 2 shows that there are significant differences between the MTRI and the nonweighted tariff average. This is not surprising, since the nonweighted tariff average bears little relationship to theoretically sound indexes such as the MTRI or the TRI. On the other hand, the values for the trade-weighted average tariffs are often quite close to the corresponding MTRI tariff values. This empirical finding converges with those of Anderson and Neary (2003) and Bach and Martin (2001) who show that the trade-weighted average tariff is a linear approximation to the tariff aggregator based on the expenditure function. In other terms, the trade-weighted average tariff plays the same role as the Laspeyres price index in consumer theory, providing a fixed-weight approximation that underestimates the "true" height of tariffs because it neglects substitution induced by tariff changes.

In the particular case of a CES aggregator function, the trade-weighted average tariff corresponds to constant expenditure shares. Constant shares correspond to the special case of a Cobb-Douglas subutility function, where $\sigma_j = 1$. In such a case, we observe the following result (proof in the Appendix).

PROPOSITION 1. *In the base equilibrium (that is, with all domestic prices equal to 1), the MTRI uniform tariff coincides*

Table 1
GTAP agricultural commodities and HS-8 tariff lines

Commodities*	GTAP classification	Number of EU tariff lines	Number of U.S. tariff lines	Elasticities of substitution
Paddy rice	1	3	3	2.2
Wheat	2	3	3	2.2
Cereal grains	3	13	12	2.2
Vegetables, fruits, nuts	4	183	186	2.2
Oilseeds	5	31	16	2.2
Sugar cane, sugar beet	6	3	2	2.2
Plant based fibers	7	4	7	2.2
Other crops	8	111	116	2.2
Cattle, sheep, goats, horses	9	14	12	2.8
Other animal products	10	73	50	2.8
Raw wool, cocoons, and hair	12	9	17	2.8
Meat: cattle, sheep, goats, horses	19	77	34	2.2
Other meat products	20	199	61	2.2
Vegetable oils and fats	21	112	70	2.2
Dairy products	22	121	118	2.2
Processed rice	23	2	3	2.2
Sugar	24	10	15	2.2
Other food products	25	580	489	2.2
Beverages and tobacco	26	87	84	3.1
Nonfood items (goods listed in URAA, beyond Chapter HS 24)	other	130	79	2.0

*Raw milk (GTAP code 20) is excluded because of absence of trade.

with the trade-weighted average tariff when the CES aggregator function becomes Cobb-Douglas.

This proposition clarifies the linkage between our MTRI estimates, using a CES aggregator function, and the trade-weighted index. Since the values of σ_j in the GTAP dataset rank between 2.2 and 3.8, it is not surprising that the MTRI uniform tariffs can be rather close to the trade-weighted average tariffs.

The MTRI uniform tariff is more likely to be higher than the trade-weighted average tariff the more elastic is the demand for tariff-constrained imports. On the basis of empirical calculations with a CGE model, Anderson and Neary

Table 2
Base tariffs (year 1995, actual bound tariffs)

Commodities	Nonweighted average tariff (%)		Trade-weighted average tariff (%)		MTRI tariff (%)		Coefficient of variation of tariffs	
	EU	U.S.	EU	U.S.	EU	U.S.	EU	U.S.
Paddy rice	58.6	3.0	80.5	1.7	80.8	1.7	0.70	0.53
Wheat	57.8	4.9	114.0	4.5	114.0	4.5	0.86	0.27
Cereal grains	45.6	1.1	84.4	0.8	89.8	0.8	0.97	1.00
Vegetables, fruits, nuts	16.8	6.9	57.5	4.2	68.9	4.5	1.28	1.21
Oilseeds	0	23.6	0	4.0	0	6.6	0	2.51
Sugar cane, sugar beet	40.3	2.9	14.2	3.7	14.8	3.7	1.02	0.40
Plant based fibers	0	11.1	0	2.8	0	2.9	0	0.87
Other crops	7.5	3.7	7.8	1.7	8.0	1.8	0.93	2.49
Cattle, sheep, goats, horses	30.2	2.1	36.2	0.1	51.5	0.0	1.52	2.36
Other animal products	4.9	1.1	2.2	0.3	2.6	0.3	1.99	2.12
Raw wool, cocoons, hair	0.1	3.5	0	5.4	0	5.4	0	1.15
Meat: cattle, sheep, goats, horses	62.1	7.0	94.0	1.1	103.2	1.1	1.02	1.67
Other meat products	35.1	4.8	24.7	1.9	26.4	2.0	1.06	0.93
Vegetable oils and fats	14.5	4.5	5.7	3.1	6.8	3.1	1.54	1.15
Dairy products	72.0	26.5	69.7	8.1	76.4	11.4	0.83	1.06
Processed rice	99.2	7.8	126.4	3.4	127.6	3.4	0.52	1.08
Sugar	39.2	26.0	63.9	13.9	67.5	15.2	0.91	1.20
Other food products	28.0	11.8	19.7	5.6	23.7	6.0	1.02	1.71
Beverages and tobacco	15.8	7.2	28.2	2.3	36.7	2.4	1.51	1.24
Nonfood items	8.6	3.0	3.6	2.1	3.7	2.1	1.38	1.20

Note: All three tariff indexes compare the actual tariff structure with free trade. See text for details.

(2003) confirm this basic insight.[9] Our empirical estimate of the MTRI leads to similar conclusions. In our specific case of a CES aggregator function, we can derive the conditions under which the MTRI exceeds the trade-weighted index:

PROPOSITION 2. *In the base equilibrium (that is, with all domestic prices equal to 1), (i) the trade-weighted average tariff overestimates the MTRI uniform tariff when $\sigma < 1$ (σ denotes, the elasticity of substitution of the CES aggregator function); (ii) the trade-weighted average tariff underestimates the MTRI uniform tariff when $\sigma > 1$.*

Looking at Tables 1 and 2, it is also obvious that the MTRI and the trade-weighted index give very similar results when the number of tariff lines in the aggregate is very small, or when there is little dispersion in tariffs within an aggregate. Figures in Table 2 show that the percentage variation between the MTRI and the trade-weighted average depends positively on the standard error of tariffs, something that is confirmed by elementary descriptive statistics. For the aggregates with a large number of products, the gap between the two indexes can be very large. Given our assumption on substitution elasticities, in the dairy sector, for example, the trade-weighted average underestimates the trade restrictiveness of the pre-URAA tariff structure by 29% in the U.S. and by 9% in the EU. This is also the case in the cattle sector and in the beverages sector in the EU (underestimation of 29 and 23%, respectively), and in the oilseeds sector in the U.S. (underestimation of 40%). Overall, for six aggregate EU products out of twenty, the trade-weighted average underestimates the MTRI by more than 10%.

In brief, the trade-weighted tariff can only be a satisfactory approximation of more theoretically consistent indicators of market access under very specific conditions and for specific values of the substitution elasticities. In more general cases, when the aggregate includes a large number of heterogeneous tariff lines and elasticities differ from unity, the trade-weighted average is a poorer indicator of the restrictiveness of the tariff structure.

5. Impact of the Uruguay Round and counterfactual scenarios

The computation of the MTRI for the year 2001 makes it possible to evaluate the trade restrictiveness of the tariff structure that resulted from the URAA. Following BFS, we also want to assess the relative effects of reducing the tariff average and tariff dispersion. We simulated two other tariff reduction schemes in addition to the actual reduction implemented by the EU and the U.S. The three cases are called Uruguay Round commitments, Swiss Formula, and uniform tariff reduction, respectively. In the three cases, we start from the same tariff structure in 1995 (that is, the initial vector p_i^{95} is the same for each case), but the three schemes lead to three different vectors for the year 2001. These may be summarized as follows:

- *Uruguay Round commitments*. The price vector p^{2001} is the one that results from the bound tariffs in the year 2001. The resulting tariff structure reflects the obligation of a 36% nonweighted average reduction, but with no constraints placed on the mix of reductions to achieve the overall average (except that each tariff line must be reduced by at least 15%).
- *Swiss Formula*. In this case, we calculate the price vector p^{2001} that would have resulted from a harmonizing tariff reduction (higher tariffs subject to larger cuts, as should be the case in the present Doha Round according to the July 2004 compromise). The formula is given in Eq. (15) and the parameter C is chosen to obtain the same nonweighted average reduction of 36% in tariffs as specified in the URAA. Comparing the value of the MTRI-uniform tariff equivalents with those that actually resulted from the URAA, we can assess the impact of commitments that would have focused more on reducing tariff dispersion than the actual URAA tariff cuts

$$t_i^{2001} = Ct_i^{1995}/(C + t_i^{1995}). \tag{15}$$

- *Uniform (i.e., radial) tariff reduction*. Under this scheme, we assume that a uniform 36% reduction is applied to all tariff lines. This will obviously result in the same average reduction as specified under the URAA, but it does not permit countries to allocate the adjustment across commodities. The comparison of the values of the MTRI-uniform tariff equivalents with those that actually result from URAA commitments therefore measures the magnitude of the "dilution effect" that resulted from the distribution of large and small or minimal cuts across tariff lines.

Comparing the values of the MTRI-uniform tariff equivalents of the 2001 tariffs (first column in Table 3) with the MTRI-uniform tariff equivalents of the 1995 tariffs (third column in Table 2), we can assess the actual impact of the URAA in terms of market access. The URAA indeed reduced each of the 20 MTRI-uniform tariffs both in the EU and in the U.S. Because both the variance and the mean of tariffs decrease (see Tables 4 and 5), it is not surprising that the MTRI uniform tariff also moves in the same direction for all aggregates, as well as at the aggregate level, confirming that the URAA increased market access. This is a consequence of the commitment to reduce each tariff line by at least 15%. The absolute values of the reductions are much smaller in the case of the U.S., as could have been expected given its lower MTRI-uniform tariff equivalents in the base period (see Table 2). This is also consistent with the BFS results suggesting that the Uruguay Round led to a larger increase in market access in the EU than in the U.S.

We now turn to the counterfactual scenarios in Table 3. If the Swiss Formula had been applied, the Uruguay Round would

[9] Anderson and Neary (2003) prove the following: "The MTRI uniform tariff exceeds the trade-weighted average tariff if (i) the compensated arc elasticity of demand for the composite tariffed good exceeds one; (ii) the composite tariffed good is normal; and (iii) the trade expenditure function is implicitly separable in tariffed and other goods."

Table 3
MTRI-uniform tariff equivalents (%) in the year 2001: actual bound tariffs and counterfactual scenarios

Commodities	Uruguay Round commitments		Swiss Formula		Uniform 36% tariff reduction	
	EU	U.S.	EU	U.S.	EU	U.S.
Paddy rice	51.9	1.1	23.9	1.5	52.0	1.1
Wheat	73.0	2.5	26.2	3.3	73.0	2.9
Cereal grains	59.9	0.3	24.1	0.7	60.7	0.5
Vegetables, fruits, nuts	58.1	3.5	21.5	2.3	51.6	3.0
Oilseeds	0.0	5.8	0	2.1	0	5.5
Sugar cane, sugar beet	12.0	1.6	9.5	2.8	9.8	2.3
Plant based fibers	0	2.3	0	1.9	0	1.9
Other crops	3.4	1.3	6.0	1.0	5.3	1.2
Cattle, sheep, goats, horses	38.9	0.0	18.8	0.0	39.4	0.0
Other animal products	1.9	0.2	1.8	0.2	1.9	0.2
Raw wool, cocoons, hair	0	4.0	0	3.6	0	3.5
Meat: cattle, sheep, goats, horses	70.5	0.7	24.9	0.8	70.7	0.7
Other meat products	17.5	0.7	13.6	1.4	17.9	1.3
Vegetable oils and fats	5.3	2.4	4.2	2.1	4.9	2.1
Dairy products	53.0	10.4	23.0	3.0	52.1	9.0
Processed rice	82.3	2.1	26.9	2.6	82.3	2.2
Sugar	55.3	6.7	21.9	5.5	45.2	10.4
Other food products	18.7	4.5	12.6	3.0	17.1	4.0
Beverages and tobacco	25.4	0.9	16.4	1.8	27.0	1.6
Nonfood items	1.4	1.3	3.0	1.4	2.4	1.4

Note: All three scenarios compare a counterfactual tariff structure with free trade. See text for details.

have led to a considerable increase in the EU market access as measured by the overall MTRI. In the EU, the Swiss Formula would have led to a dramatic decrease in trade restrictions in highly protected sectors such as grains, meat, and dairy, as well as in sectors characterized by a high tariff dispersion, such as fruits and vegetables. The U.S. market also would have been more open at the aggregate level (see Table 4), but in several cases the Swiss Formula does not provide a significant improvement in market access compared to the other schemes (unlike in the EU). Clearly, the impact of Swiss Formula tariff reduction is larger in the EU than in the U.S.

Tables 3–5 show that the URAA increased access to the market in a way that is very comparable to what would have resulted from a uniform tariff reduction in most sectors. This means that both countries have not allocated tariff cuts in a very “strategic” way. The “dilution” of the tariff reduction effect was particularly limited in the EU, as could have been expected since most tariffs were cut by 36% and no tariff was reduced by less than 20%.

6. Comparison with previous results and sensitivity

The comparison of the MTRI-uniform tariff equivalents between the URAA commitments and the counterfactual scenarios confirms BFS’s conclusions that the dilution of tariff cuts has had overall a limited impact on market access in the EU. It also confirms that harmonizing formulas would have resulted in much larger market access than that which occurred with the Uruguay Round discipline, especially in the EU.[10] In order to check the consistency of the numerical results with those of BFS, we need to compute, for the entire dataset, the uniform tariff surcharge (i.e., the extra rate to be applied to the nonuniform tariff vector of tariffs in period 1), which compensates the nonuniform change in the tariff structure (see Section 2.1). In practice, the overall MTRI-uniform tariff factor surcharge is obtained by solving for μ in Eq. (12):

$$\sum_j \sum_i p^*_{ij}\beta_{ij} \times \left(\frac{\left(\beta_{dj}(p_{dj})^{1-\sigma_j} + \sum_i \beta_{ij}(p^1_{ij}(1+\mu))^{1-\sigma_j}\right)^{-\sigma_j}}{p^1_{ij}(1+\mu)} \right) \times e^0_j = \sum_j \sum_i p^*_{ij} I^0_{ij}. \tag{12}$$

Given the differences in the methodological approaches followed, the results presented in Table 6 are surprisingly similar. Only in the case of the Swiss Formula is the difference substantial. This is the scenario that implies the largest change in tariffs; in such a case, then, the higher substitutability implied by the CES functional form leads to a higher impact.

Finally, we turn to sensitivity analysis of our simulation results, in order to check to what extent the assumed values of the

[10] Recall that the tariff reduction procedure agreed upon on July 31, 2004, and whose modalities are presently under negotiation, relies on deeper cuts in higher tariffs. The effects are, in practice, very similar to the Swiss Formula.

Table 4
U.S. aggregate results

Tariff structures (*ad valorem* equivalent, in percentage)	Standard deviation	Mean* (%)	MTRI uniform tariff (%)	Trade-weighted tariff average (%)
Base rates (year 1995)	18.3	9.7	3.5	3.3
Bound rates UR commitments (year 2001)	15.5	7.1	2.4	2.2**
Swiss Formula scenario (year 2001)	3.5	3.5	1.9	1.7**
Uniform reduction scenario (year 2001)	11.7	6.2	2.4	2.1**

*Nonweighted arithmetic mean; **weighted by 1995 import values.

Table 5
EU aggregate results

Tariff structures (*ad valorem* equivalent, in %)	Standard deviation	Mean* (%)	MTRI uniform tariff (%)	Trade-weighted tariff average (%)
Base rates (year 1995)	38.6	26.7	32.4	25.5
Bound rates UR commitments (year 2001)	26.8	17.9	25.6	17.8**
Swiss Formula scenario (year 2001)	7.8	11.1	13.4	8.4**
Uniform reduction scenario (year 2001)	24.7	17.1	24.7	16.3**

*Nonweighted arithmetic mean; **weighted by 1995 import values.

substitution elasticities affect the MTRI computation. As was mentioned in Section 2.3, even though the elasticities extracted from the GTAP dataset are widely used by applied analysts, their relevance is questionable. There are several reasons to believe that the GTAP elasticities are low, compared to what is consistent with recent econometric estimates of import elasticities (see e.g., Erkel-Rousse and Mirza, 2002; Hummels, 1999). In order to assess the sensitivity of the results to the choice of the parameters of the CES function, we computed the overall MTRI-uniform tariff equivalents, making different assumptions about the values of the substitution elasticities (Table 7). The elasticities are assumed to range from one-third to three times the original values. Even though the ranking among different scenarios remains the same for the various assumptions, the MTRI is obviously quite sensitive to the degree of substitution between products, a result consistent with *Proposition 2*. Since the large values of the index are more sensitive to the assumption on substitution, the EU results are more affected by changes in the σ_j's than the results for the U.S., where the agricultural sector is less protected.

7. Conclusion

The results of our comparison of tariff indexes and tariff reduction scenarios should be used with caution in policy analysis. Indeed, our figures for tariffs after the Uruguay Round do not correspond to the actual EU and U.S. protection. The reason is that, for the purpose of comparison between scenarios, the world price was kept the same as in the initial (1995) situation. In addition, the actual protection of EU and U.S. agriculture is clearly overestimated because we focused on the MFN tariffs. That is, we ignore preferential tariffs, which affect roughly one third of the value of the EU imports. However, by computing sectoral indexes, our approach provides a more detailed assessment of the market access improvement in the EU and the U.S. than previous studies (e.g., BFS). Because we manage to approximate the MTRI uniform tariff without using a CGE model, we are able to take into account the large number of different tariffs that characterize agriculture in most WTO countries.

Our computation of the absolute level of the MTRI shows that access to the EU market is still far more restricted than to the U.S. market, at least for countries that do not benefit from preferential treatment. On a nonweighted basis, the overall average tariff on agricultural and food products was 26.7% in the EU and 9.7% in the U.S. in 1995, while the trade-weighted average tariff was, respectively, 25.5% and 3.3%. The MTRI-uniform tariff measures a degree of trade restrictiveness of 32.4% for the EU and 3.5% for the U.S. (see Tables 3 and 4). The reason why the MTRI gives a different picture is that the high tariffs in the U.S. are set on a restricted set of particular goods. In contrast, in the EU, most of the commodities imported in large quantities face significant MFN tariffs.

Table 6
Comparisons of MTRI-uniform tariff surcharges with BFS (2000) rates of change (absolute values in %)

	European Union			United States		
	Uruguay	Swiss	Uniform	Uruguay	Swiss	Uniform
μ	5.4	16.8	6.2	1.0	1.3	1.0
BFS	5.7	10.6	6.3	1.0	1.1	1.0

Note: All tariff indexes compare the initial (1995) tariff structure with the new (2001) ones. See text for details.

Table 7
Sensitivity of the MTRI uniform tariff to changes in the elasticities of substitution (in %)

	European Union				United States			
	Base	Uruguay	Swiss	Uniform	Base	Uruguay	Swiss	Uniform
0.3* σ_j	26.0	17.4	9.3	16.6	3.2	2.2	1.8	2.1
1.3* σ_j	36.5	29.0	14.9	28.0	3.7	2.6	2.0	2.6
2* σ_j	45.5	36.5	17.3	35.4	4.3	3.1	2.3	3.1
3* σ_j	59.8	47.0	18.9	45.5	6.2	4.9	3.2	5.0

On the methodological side, the MTRI uniform tariff and the trade-weighted index tend to move closely together when the number of commodities is small, and when the dispersion of tariffs is low. In other cases, the trade-weighted index underestimates the true impact of the tariff structure on market access, as measured by the MTRI. When we aggregate a large number of tariffs, or when the dispersion is large, the two indexes differ significantly.

The difference that we observe between the MTRI uniform tariff and the nonweighted tariff average suggests that models that rely on aggregate tariffs constructed as simple averages use poor estimates of the actual tariff structure. This bias is likely to affect a large number of studies, as it is common practice to construct aggregate tariffs as simple averages of the detailed tariffs applied by custom officers, who sometimes work at a level of detail corresponding to the 8- or 10-digit level (or even 14-digit in the case of the EU). Constructing the aggregate tariffs used in trade models as trade-weighted averages is more satisfactory. However, when aggregating a large number of goods with a large tariff dispersion into a single commodity, this method also results in significant bias, usually an underestimation of the aggregate tariff, as measured by the MTRI.

The computation of the absolute levels of the MTRI index makes it possible to compare the strategies in the allocation of tariff reductions taking into account the difference in the initial (bound) tariffs of the EU and the U.S. We are also able to assess the consequences of emphasizing reductions in tariff dispersion in terms of getting a (more) level playing field between the EU and the U.S. Overall, our results confirm the intuition by BFS: (i) the "dilution" of tariff cuts in the URAA had a limited impact on overall market access, (ii) in the Doha Round, a harmonizing formula would provide a significant improvement in market access, which would not be the case with an average reduction. The July 2004 Decision states that higher tariffs will face larger cuts. Nevertheless, if "sensitive sectors" are excluded from this discipline, the market access improvement will be limited, especially in the U.S., where high tariffs are concentrated in a few sectors.

The behavioral parameters make a great difference in our simulated outcomes. In the past, Shoven and Whalley (1984, p. 1047) have argued "for the establishment of an "elasticity bank" in which elasticity estimates would be archived, evaluated by groups of experts." Such a proposal could be more realistic now that we have examples of widely accessible global databases, and that much progress has been made in the area of aggregation and demand system estimation: this greatly reduces the dimensionality of the demand systems that can be used in trade models.[11]

[11] As pointed out by an anonymous referee, Lewbel (1996) developed simple tests for aggregation based on time-series properties of price data, while Capps and Love (2002) used these tests and showed that reliable demand systems can be estimated from the aggregates.

In brief, this article provides a summary measure of the Uruguay Round tariff reduction commitments in the EU and the U.S., taking into account the impact of changes in a large number of tariff lines. The impacts of alternative tariff-cutting procedures are evaluated using the MTRI as the tariff aggregator. We are able to compute the index for particular commodity aggregates without using a CGE model, but we assume a specific functional form for import demand. This approach is easy to implement: it requires only information on tariffs, import values, and total expenditure on each commodity (in addition to the knowledge of the parameters of the demand function). This comes at a cost, namely the need to specify a tariff aggregator function, which also requires restrictive assumptions. Trade weighted indexes underestimate protection. But while a CES-based MTRI provides a more theoretically consistent operational measure, the results are inherently sensitive to assumptions regarding product substitution, on which there is still little reliable information available.

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Appendix

Proofs of Propositions

Proof of Proposition 1. With all domestic prices equal to 1 in the base equilibrium, Eq. (9) becomes

$$\sum_i p^*_{ij}\beta_{ij} \times \frac{1}{\left(\beta_{dj}(p_{dj})^{1-\sigma_j} + \sum_i \beta_{ij}(p^*_{ij}(1+\tau_j))^{1-\sigma_j}\right)[p^*_{ij}(1+\tau_j)]^{\sigma}} = \sum_i p^*_{ij}\beta_{ij}. \tag{A.1}$$

When $\sigma_j = 1$, the MTRI-uniform tariff equivalent is

$$\tau_j = \frac{1-\beta_{dj}}{\sum_i \beta_{ij} p^*_{ij}} - 1. \tag{A.2}$$

Recalling that in the base equilibrium $p_i^* = \frac{1}{1+t_i}$, from the above equation we obtain

$$\tau_j = \frac{\sum_i \beta_{ij} t_{ij}}{\sum_i \beta_{ij}}. \quad \text{(A.3)}$$

This proves the proposition.

Proof of Proposition 2. We first write Eq. (9) as follows (dropping the *j* index for the sake of simplicity):

$$\sum_i p_i^* \beta_i \left(\frac{P^\tau}{p_i^*(1+\tau)}\right)^\sigma e^0 - \sum_i p_i^* I_i^0 = F(\tau,\sigma) = 0. \quad \text{(A.4)}$$

Assuming that there is a solution $F(\tau^0, \sigma^0) = 0$ and $F_\sigma(\tau^0, \sigma^0) \neq 0$, then by the implicit function theorem in the neighborhood of (τ^0, σ^0) there exists a function $\tau^0 = f(\sigma^0)$ and

$$\frac{d\tau}{d\sigma} = -\frac{F_\tau}{F\sigma}\Big|_{\tau=f(\sigma)}. \quad \text{(A.5)}$$

The derivatives of the F function are $F_\tau < 0, F_\sigma > 0$. Indeed,

$$F_\tau = -\sigma \frac{e^0}{(1+\tau)^2} \sum_i \beta_i \left(\frac{P^\tau}{p_i^*(1+\tau)}\right)^{\sigma-1},$$

which is negative, while

$$F_\sigma = \sum_i e^0 \beta_i p_i^* \left(\frac{P^\tau}{(1+\tau)}\right)^\sigma \ln\left(\frac{P^\tau}{(1+\tau)}\right)$$

is positive, since

$$\left(\frac{P^\tau}{(1+\tau)}\right) \to 0 \Rightarrow \left(\frac{P^\tau}{(1+\tau)}\right)^\sigma \ln\left(\frac{P^\tau}{(1+\tau)}\right) \to 0$$

and $\sigma > 0$. Because the derivatives have opposite signs, τ increases with σ (at least in the case in which a solution exists). Recalling from Proposition 1 that the MTRI and the trade-weighted average tariff coincides for $\sigma = 1$, the result follows immediately.

This is illustrated in Fig. 1, drawn in the space of uniform tariff τ and elasticity of substitution σ. The trade-weighted average tariff, which corresponds to point A, is drawn as a straight line, as it does not change with the value of the elasticity of substitution. We need to locate the points corresponding to the MTRI uniform tariff. They lie on the locus F^0, which from the previous results must be upward sloping. At point B, which corresponds to $\sigma = 1$, we know from Proposition 1 that τ must be equal to the trade-weighted average tariff. When the elasticity of substitution is lower than 1, the trade-weighted average tariff overestimates the MTRI uniform tariff, while the opposite is true for elasticity values greater than 1. This finding is fully consistent with our empirical results, since all the elasticities used in our calculations exceed 1 (Table 1) while the trade-weighted average tariff never exceeds the MTRI uniform tariff (Table 2).

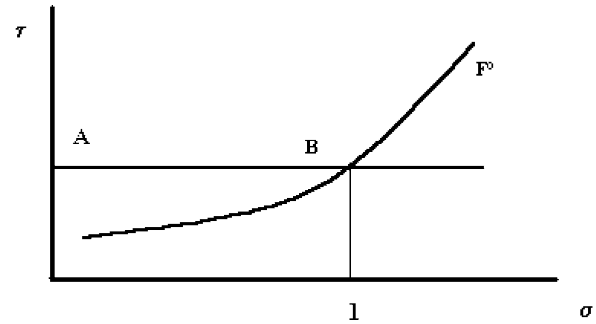

Fig. 1. Sensitivity of the uniform tariff equivalent to the elasticity of substitution.

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