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# Methods to Aggregate Import Tariffs and their Impacts on Modeling Results

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*When impacts of WTO market access proposals are analyzed with economic trade models, it is necessary to aggregate tariff data from the detailed tariff line level to the model level. In this article import tariffs and implemented import tariff cuts are aggregated from the HS6-digit tariff line level with the simple and trade weighted average, the Trade Restrictiveness Index (TRI) and the Mercantilist Trade Restrictiveness Index (MTRI) by considering bound and applied tariff rates. The resulting tariffs are substituted for the originally applied import tariffs of the GTAP data base. Multilateral trade liberalization scenarios are then implemented and the welfare effects are compared.*

• **JEL classification:** F13, F17, Q17
• **Key words:** import tariff aggregation, tariff cutting scenarios, bound and applied tariffs, WTO negotiations, CGE modeling, agricultural trade policy

## I. Introduction

Trade policy is carried out on the very detailed level of tariff lines, for which several million pieces of tariff information exist. The consumption and production data needed for economic models of trade are, however, only available at a much

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higher aggregation level. Due to the rare availability of these data at the tariff line level, there are only a few practical possibilities for carrying out a theoretically based aggregation. Up until now, mainly simple or trade weighted averages of the tariff data were used in modeling (Manole and Martin, 2005).

There is a growing body of literature on alternative aggregation methods. Anderson and Neary (1994, 2003) developed two theory-based indices: the Trade Restrictiveness Index (TRI) and the Mercantilist Trade Restrictiveness Index (MTRI). While the first index measures the uniform welfare equivalent trade restriction, the second index is an import equivalent method. Most of the empirical studies that apply these indices use them for descriptive purposes and to compare the outcomes of different tariff aggregation methods on that level. Only a few studies exist that incorporate different tariff aggregates into economic trade models and empirically analyze their impact on welfare results. Yu (2007) compares the simple average tariff with the trade weighted average for Least Developed Countries (LDCs) with the Global Trade Analysis Project (GTAP) model and finds that the trade weighted average underestimates the welfare impact of preference erosion. Manole and Martin (2005) analyze the trade weighted average tariff, a tariff revenue aggregator and an expenditure aggregator within a general equilibrium model of a small open economy with two sectors and three goods. The results of their analysis show that the welfare effects of trade liberalization are significantly underestimated with trade weighted average tariffs in comparison to the other two aggregators.

This paper builds on Pelikan and Brockmeier (2008) and aims to contribute to the relevant literature in the following ways: On the methodological level, it presents aggregation methods that are applicable to large data sets of economic trade models with bilateral trade flows. On an empirical level, it is based on work by Kee et al. (2005a, 2005b) but it newly derives a three dimensional index for each product, importer and exporter from the HS6 tariff line level for the entire data base of the GTAP model. The originally applied import tariffs of the standard GTAP data base are replaced with the newly derived tariffs. Thereby, the simple average and the trade weighted average tariff, the TRI and the MTRI are compared with each other. To our knowledge, no empirical study has been carried out that applies and compares the TRI and MTRI using an entire data base for a multi-sectoral, multiregional trade model. Additionally, all studies that derive the TRI and MTRI for descriptive purposes use either the bound or the applied tariff rates. Our study closes this gap in the literature and takes bound and applied tariffs into account. Furthermore, tariffs are cut at the HS6 tariff line level according to a tiered harmonization formula considering both tariff forms.

The paper is organized as follows: section two of this paper describes the theory of the implemented tariff aggregation method and gives a short overview of the current literature on this topic. In section three a simple, partial equilibrium calculation of the TRI and the MTRI is applied to aggregate tariffs from the HS6-digit tariff line level to the level of the GTAP model. Taking import demand elasticities from Kee et al. (2005a) and using the MAcMap and COMTRADE data base, we calculate aggregated bound and applied import tariffs. Based on the ongoing political debate in the WTO negotiations, a multilateral trade liberalization scenario according to the G-20 proposal (October 2005) is set up at the tariff line level. In section four, the modeling results are compared by considering the welfare effects. The focus of the discussion is on the EU-27. Thereby the following questions will be addressed: How do the different aggregation methods influence simulation results of the GTAP model? Is it possible to find a rationale for the differing of the results or are they different by chance? Finally, the paper ends with conclusions drawn from this work.

## II. Economic Theory of Tariff Aggregation Methods

In the literature, a great variation of tariff aggregation methods are described and used for empirical analysis. In this study, the simple average tariff, the trade weighted average tariff, the TRI, and the MTRI are applied. Therefore, only these four methods are discussed in the theoretical part of this paper. (For a broader discussion of tariff aggregators see Cipollina and Salvatici (2006)).

### A. Simple Average

The simplest aggregation method is the unweighted arithmetical mean (simple average). This method gives the same weight to each tariff line. It is mainly applied when no data is available for the use of other methods. This is often the case when tariffs are aggregated from the HS12, HS10 or HS8 to the HS6-digit tariff line level.

The simple average does not consider the relative importance of the tariffs (Bach et al., 2001). Also the tariffs should be as normally distributed as possible in order to obtain representative results. As pointed out by Manole und Martin (2005), this aggregation method it is very susceptible to manipulation. In the calculation of the average tariffs, thousands of tariff lines can be added with a tariff rate of zero but no corresponding trade flow, and thus be of no significance for the particular country. Yet, in this manner, a very low average tariff can be achieved which does not reflect the real level of protection.

## B. Trade Weighted Average Tariffs

The tariff aggregation based on weighting by import values is the most commonly used aggregation method in modeling (Manole and Martin, 2005). This method considers the relative importance of trade flows. The greater the importance of a product for trade, the greater the weight given to the product in the aggregation. One advantage compared to other aggregation methods is that the import values of tariffs are accessible and internationally documented up to the 6-digit level. Thus, the necessary data can, for example, be easily calculated with the WITS[1] Software (World Integrated Trade Solution) from the COMTRADE data base.[2] Additionally, the trade weighted average tariff is consistent with the national accounts of most trade models.

The problem with this method is that the measured protection itself endogenously influences the aggregation. If an import tariff increases, and, as a consequence, the import demand decreases, the weight of the tariff also loses importance. In contrast, the welfare loss of a tariff increases with the increase of the prevailing import tariff. The tariffs have a greater effect on welfare and traded quantities in the case of a relatively elastic import demand than with a relatively inelastic import demand function. However, the import weighted tariff shows high values, especially for tariffs of products with inelastic demand. Additionally, prohibitive tariffs are assigned weights of zero, although the welfare losses are at maximum. This endogenous bias consequently leads to an underestimate of the tariff restrictions.

There are different approaches in the literature which aim to minimize the endogeneity bias associated with import weighting. For example, Wainio and Gibson (2004) use export values as weights and Bouët et al. (2004) propose a weighting based on reference groups. Additionally the weighting of tariffs with non-distorted values is often presented as an alternative method. Anderson and Neary (2005) show, however, that weighting with the undistorted import values can reduce the endogeneity bias. In contrast, a correct presentation of welfare and traded quantities is not given, since import demand elasticities are not considered. Another disadvantage

[1]cf.: http://wits.worldbank.org/witsweb/default.aspx

[2]United Nations Commodity Trade Statistics Data Base: http://unstats.un.org/unsd/comtrade/default.aspx

of this method is that the import values are difficult to measure under free trade.

## C. Trade Restrictiveness Index

The Trade Restrictiveness Index (TRI) developed by Anderson and Neary (1994) enables welfare based aggregation of the tariffs. It represents the trade restrictions that are welfare equivalent to the initial disaggregated protection structure on the aggregated level. It therefore answers the question: Which uniform tariff would keep welfare constant? (Kee et al., 2005b)

Anderson and Neary (1996, 2005) derive the TRI as a general equilibrium application from the distance function developed by Deaton (1979). They define the TRI as an inverse, uniform, tariff factor which compensates the representative consumers for a current welfare change, while holding the balance of trade constant. Most current studies on the TRI use this general equilibrium application (i.e., Anderson and Neary, 2005; Bach and Martin 2001; Salvatici, 2001). The advantage of this method is the theoretical consistency. However, it does not enable one to capture a detailed tariff structure, since the necessary data are not available at this detailed level (Cipollina and Salvatici, 2006). For the general equilibrium application, the tariffs are aggregated first with the help of other methods (i.e., with trade weights) and then the welfare equivalent protection level is calculated.

It is, however, possible to implement the TRI in a partial equilibrium framework (Anderson and Neary, 2005). Bureau and Salvatici (2004a and 2004b), for example, calculate the product specific TRI for the agricultural sector of the EU-15 and the USA. They aggregate the bound tariffs from the HS8 level to the GTAP sector level. The necessary elasticities are taken from the GTAP data base and are thus only available at the aggregated level. The import demand is calculated in this study with a CES (Constant Elasticities of Substitution) function. Kee et al. (2005b) calculate the TRI for 91 countries under consideration of tariff and non tariff trade barriers. For this purpose they aggregate all applied tariffs from the HS6 level to the country level, so that one tariff per country is displayed. The import demand is modeled with a linear function. Bureau et al. (2000) calculate the percentage changes of the TRI based on bound tariffs at the HS8 level for the EU and the USA. Here, the TRI based on data from the year 1995 is compared with the TRI in the year 2000. The necessary import demand elasticities are estimated at the HS4-digit tariff line level.

Different studies show that various simplifying assumptions must be accepted to empirically calculate the TRI. Particularly a lack of data availability at the detailed tariff line level complicates the use of this concept in applied modeling. In the partial application of the TRI, no cross price effects or income effects are considered, and changes in trade policy do not capture intersectoral effects. Also, the assumption of a small country does not permit the consideration of terms of trade effects. Thus, the tariffs cannot affect the world market prices, and the welfare equivalence is expressed only through a change in the allocation efficiency. In contrast to the trade weighted average tariff the TRI can overestimate the tariff receipts. This is particularly important in developing countries because they obtain a high share of their national budget from tariff revenues.

## D. Mercantilist Trade Restrictiveness Index

The Mercantilist Trade Restrictiveness Index (MTRI) is also defined by Anderson and Neary (2003) and based on Corden (1966). With the help of this index, the import volume equivalent protection is measured. The index shows how strongly national protection distorts the imports from the rest of the world. It is defined on the basis of an aggregated tariff, resulting in the same import volume as the initial vector of non-aggregated tariffs at world market prices (Anderson and Neary, 2003). Thus, the index measures the uniform tariff, which keeps imports constant (Corden, 1966).

Analogous to the TRI, most empirical calculations of the MTRI are done as a general equilibrium calculation (Cipollina and Salvatici, 2006). Anderson and Neary (2005), or Antimiani and Salvatici (2005), for example, use this form. While work in the first study is done on the HS4 level, it is carried out in the second study at the GTAP model level. The detailed tariff data are brought up to the appropriate level with trade weights in both studies.

The MTRI can also be calculated with the help of a partial equilibrium application. Thereby, the MTRI is often expressed as an import value equivalent tariff originally proposed by Corden (1966). Kee et al. (2005b) derive the MTRI, for example, on the basis of an import value equivalent tariff, and call it Overall Trade Restrictiveness Index (OTRI). In the framework of the above mentioned study, they calculate applied tariffs and non tariff barriers at the HS6 level and aggregate them to the source and product generic country level.

Bureau and Salvatici (2004b) calculate the product specific MTRI for the agricultural sector of the EU-15 and the USA and Bureau et al. (2000) calculate the changes in the MTRI for the EU and the USA through the implementation of the Uruguay Round Agreement. The import and tariff data in both studies are also identical with the data used to calculate the TRIs.

## III. Methodology

### A. Empirical Estimation of the Tariff Aggregators

Three dimensional arrays have to be created to compute the simple and trade weighted average tariff, the MTRI, and the TRI for use in economic trade models which are based on bilateral trade matrices. In the disaggregated data set each import tariff is raised by a importer $s$ for imports from a partner $r$ for each tariff line $j$ ($j=1,\ldots,n$). For integration into the GTAP model, tariffs are aggregated to the model region of a single importing country $s$ for each model sector $i$, and each trading partner $r$, whereas the partner country can be a single country or an aggregated model region, respectively.

Equations (1) and (2) are used to calculate the simple average $t_{irs}^{av}$ and the trade weighted average tariff $t_{irs}^{tw}$.

$$t_{irs}^{av} = \frac{1}{n}\sum_{j=1}^{n} t_{jirs} \tag{1}$$

$$t_{irs}^{tw} = \sum_{j=1}^{n} w_{jirs}^{*} \cdot t_{jirs} \tag{2}$$

The weight $w_{jirs}^{*}$ is based on the import quantity $q_{jirs}$ and the world market price $p_{jirs}^{w}$ for each product $j$ at the tariff line level:

$$w_{jirs}^{*} = \frac{q_{jirs} \cdot p_{jirs}^{w}}{\sum_{j=1}^{n} q_{jirs'} \cdot p_{jirs}^{w}} \tag{3}$$

The empirical estimation of the TRI and MTRI is carried out according to a partial equilibrium approach that is applied to the entire tariff data base of the GTAP model. Following Feenstra (1995) and Anderson and Neary (2005), the TRI is calculated from the linear import demand curve given below:

$$q_{jirs} = a_{jirs} - b_{jirs} \cdot p_{jirs} \tag{4}$$

Where the constant $a_{jirs}$ stands for the point at which the demand curve of $j$ intersects the ordinate and $b_{jirs}$ describes the slope of the demand curve. At the price $p_{jirs}$ the quantity demanded of product $j$ is $q_{jirs}$. The welfare loss ($W_{jirs}$) arising from an import tariff can be formally presented as:

$$W = \int_0^{p^d_{jirs}} q_{jirs} dp^d_{jirs} - \int_0^{p^w_{jirs}} q_{jirs} dp^w_{jirs} - q^d_{jirs} \cdot (p^d_{jirs} - p^w_{jirs})$$
$$= (a_{jirs} \cdot p^d_{jirs} - 0.5 b_{jirs} \cdot (p^d_{jirs})^2) - (a_{jirs} \cdot p^w_{jirs} - 0.5 b_{jirs} \cdot (p^w_{jirs})^2) \tag{5}$$
$$- (a_{jirs} - b_{jirs} p^d_{jirs} (p^d_{jirs} - p^w_{jirs}))$$

$p^d_{jirs}$ domestic price of product $j$, $p^d_{jirs} = p^w_{jirs} + p^w_{jirs} \cdot t_{jirs}$

Rearranging the expression in Equation (5) results in:

$$W_{jirs} = \frac{(t_{jirs} \cdot p^w_{jirs})^2 \cdot b_{jirs}}{2} \tag{6}$$

The total welfare loss in a sector $i$ caused by all tariffs of country $s$ on imports from country $r$ can be expressed as $\sum W_{jirs} = W_{irs}$, so that the welfare equivalent tariff $\Delta t^{TRI}$ is defined by:

$$\sum_{j=1}^{n} [(\Delta t^{TRI}_{irs} \cdot p^w_{jirs})^2 \cdot b_{jirs}] = \sum_{j=1}^{n} [(t_{jirs} \cdot p^w_{jirs})^2 \cdot b_{jirs}] \tag{7}$$

The left hand side thereby shows the hypothetical welfare loss, while the right hand side expresses the welfare loss which actually occurs. A rearrangement of Equation (7) results in Equation (8):

$$\Delta t^{TRI}_{irs} = \left( \sum_{j=1}^{n} \left[ \frac{\varepsilon_{jirs} \cdot w^*_{jirs}}{\sum_{j=1}^{n} [\varepsilon_{jirs} \cdot w^*_{jirs}]} \cdot t^2_{jirs} \right] \right)^{0.5} \tag{8}$$

The MRTI $(\Delta t^{MTRI})$ is calculated based on a concept by Corden (1966) and Anderson and Neary (2005). It is also derived from a linear import demand function. In this application the import value is used as the relevant metric to calculate the MTRI such that the index is implicitly defined by Equation (9):

$$\sum_{j=1}^{n} [p^w_{jirs} \cdot [a_{jirs} - b_{jirs} \cdot (1 + \Delta t^{MTRI}_{jirs}) \cdot p^w_{jirs}]] = \sum_{j=1}^{n} [p^w_{jirs} \cdot [a_{jirs} - b_{jirs} \cdot (1 + t_{jirs}) \cdot p^w_{jirs}]] \tag{9}$$

The left hand side of the equation describes the total value of imports created when the uniform tariff is employed. The right side of the equation defines, in contrast, the total value of all imports under the given tariffs. Through a rearrangement of Equation (9) the following equation can be derived:

$$\Delta t_{irs}^{MTRI} = \left( \sum_{j=1}^{n} \left[ \frac{\varepsilon_{jirs} \cdot w_{jirs}^{*}}{\sum_{j=1}^{n} [\varepsilon_{jirs} \cdot w_{jirs}^{*}]} \cdot t_{jirs} \right] \right) \tag{10}$$

Where $\varepsilon_{jirs}$ is the elasticity of import demand of product $j$.[3]

Equations (8) and (10) serve to calculate the TRI and the MTRI in the empirical part of this article.[4]

## B. Data Set

For the empirical part of this analysis the data is taken from the literature. This data has been adjusted to address the specific question under consideration, e.g., the calculated trade weighted and the simple average tariff only include tariff lines for which elasticity data exists. Otherwise it is not possible to correctly compare the different methods.

The tariff data used for the calculations stem from the MAcMap[5] (Market Access Map) data base, developed through a combination of the information from the data bases COMTRADE, TRAINS, AMAD and the WTO data base. MAcMap provides information on preferential tariffs, tariff rate quotas (TRQs) and a consistent conversion of specific tariffs into AVEs. The information on preferential tariffs is taken from the TRAINS data base and extended with national sources. AVE calculations are based on the median unit value of world-wide exports originating from a reference group to which an exporter belongs. These values are computed using a three year average trade flow based on the 2000-2002 period (Bouët et al., 2004). The calculation of the AVEs for the bound tariffs is conducted with the help of average world import unit values for the same year (Bchir et al., 2006). If a tariff line includes TRQs, these are converted with the help of the fill rate of the AMAD data base. If the fill rate is less than 90 per cent, the tariff is used within the quota. If, in contrast, the fill rate is greater than 99 per cent, the out of quota tariff is implemented. Should the filling rate be between 90 per cent and 99 per cent, a simple average of the in and out of quota tariff is created (Bouët et al., 2004).

[3]In our empirical analysis we use source (partner) generic import demand elasticities ($\varepsilon_{jis}$).

[4]Kee et al. (2005b) apply these as well.

[5]http://www.cepii.fr/anglaisgraph/bdd/macmap.htm

The trade data used as weights come from the COMTRADE data base and reflect an average of the years 2000, 2001, and 2002. The internal trade in the EU-15 and the new member states is excluded from the calculation. Furthermore the tariff data of the EU-15 is transferred to the 12 new EU member states. Thus, the EU enlargement is simulated at the tariff line level in concordance with the model simulations.

The import demand elasticities used are estimated by Kee et al. (2005a) at the HS6-digit tariff line level with a semi-flexible translog function. Thereby, the elasticities defined are source generic, i.e., the import demand elasticities are not differentiated by trading partner. The method is based on work by Kohli (1991) and Harrigan (1997), whereby imports are included as inputs in a GDP function. World market prices, factor endowment, and a Hicks neutral productivity are included as exogenous variables in the function. The calculation with a GDP-based function requires that the imported goods be processed domestically. Against the background of increasing vertical integration, and the assumption that even in the case of imported processed products a value adding occurs through transport and marketing in the importing country, this GDP-based function is more frequently being used to estimate such elasticities (Kee et al., 2005a).

## C. Computation of Different Scenarios

In the empirical part of this paper, a multilateral trade liberalization scenario is carried out to show the effects of the different tariff aggregation methods on modeling results. Therefore, an extended version of the comparative static standard multiregional general equilibrium GTAP model[6] is applied.

Before the actual simulations are carried out, some pre-simulations are implemented to extend the model structure and to update the protection rates. The focus of the extension is on the EU-27. Therefore instruments of the Common Agricultural Policy (CAP) and the common budget of the EU are included into the GTAP model.

Based on the results of the pre-simulation, a base run is conducted which projects the exogenous variables population, GDP and factor endowment up to the year 2014. Additionally, the Agenda 2000, the EU enlargement and the EBA agreement as well as the Mid Term Review (MTR) are implemented in 2004, 2010 and 2014, respectively. The base run only considers policy interventions in the EU-15 and in the 12 candidate accession countries. Parallel to the base run, a scenario

[6]The framework of the standard GTAP model is well documented in Hertel (1997) and available on the Internet (www.gtap.agecon.purdue.edu).

is implemented as well. It takes account of the same projections and policy shocks (Agenda 2000, EU enlargement, EBA agreement and MTR), but in the time period from 2010 to 2014, it additionally implements the WTO scenarios. The latter final step is in the focal point for the following analysis.

Concerning market access, the agricultural tariffs are cut according to the proposed tiers and the capping of the G-20 proposal of October 2005 (compare Table 1). In addition to the tariff cuts to open agricultural markets, tariffs of non-agricultural commodities are reduced by 50 per cent and 35 per cent in the developed and developing countries,[7] respectively. LDCs are exempted from tariff reductions in all scenarios. Agricultural export subsidies are also eliminated in all scenarios.[8]

In total, four scenarios are conducted by employing different aggregation methods based on the simple and trade weighted average, the TRI, and the MTRI. It is necessary to aggregate the tariffs before and after the tariff cut accordant to the measure under consideration.[9] Tariffs are calculated for each scenario as follows: Both the initial base data and the reduced tariffs are aggregated from the HS6-digit tariff line level to the model level. In a first step, the original base data in the GTAP model are replaced by the new base data. At this point, the GTAP data base contains the new applied tariffs at the base level. In a second step, the tariff data including all AVEs are cut at the HS6-digit tariff line level in the data base. Thereby, we reduce the bound tariff rate. If the new bound tariff is smaller than the MFN tariff

**Table 1.** Agricultural Tariff Cuts of the G-20 Proposal Used in the Simulations

| Developed Countries | | Developing Countries | |
|---|---|---|---|
| Tariff rate (%) | Tariff cut (%) | Tariff rate (%) | Tariff cut (%) |
| >75 | 75 | >130 | 40 |
| >50 ≤ 75 | 65 | >80 ≤ 130 | 35 |
| >20 ≤ 50 | 55 | >30 ≤ 80 | 30 |
| 0 ≤ 20 | 45 | 0 ≤ 30 | 25 |
| Cap: 100% | | Cap: 150% | |

*Source:* G-20 (2005).

[7]Country classification into developing, developed or industrialized countries is applied according to the WTO classification. Thus economies in transition are not explicitly named.

[8]For the domestic support pillar, we follow the assessment of Brink (2006) and Blandford (2005) that neither of the currently available proposals will highly constrain domestic support. Therefore, domestic support is kept unchanged for all countries and regions in all scenarios.

[9]For this purpose a program is developed applying the Statistical Analysis Software (SAS).

or the preferential tariff, the applied rate is reduced to the level of the new bound rate. The reduced tariffs are aggregated with the help of the same aggregation measure that is used for the generation of the base data. Finally, a shock is implemented in the GTAP model according to the difference between the tariff rate before and after the cut.

## IV. Results

In Section 2, it was shown that only a few partial equilibrium applications of the TRI or MTRI exist. In the studies by Bureau and Salvatici (2004a and 2004b), and Bureau et al. (2000), only the bound tariffs are analyzed, while Kee et al. (2005b) concentrate on the applied tariffs and non tariff measures. Until now there has been no study in which both bound and applied tariffs are considered for the calculation of the TRIs or the MTRIs.

Anderson and Martin (2006) say that the difference between bound and applied tariffs is of great importance, particularly for developing countries. In contrast, in the high income economies, there is only a slight difference between bound and applied tariffs. However, all studies explain this statement on the basis of average tariffs (e.g., Walkenhorst and Dihel, 2003) or trade weighted tariffs (e.g., Bchir et al. 2006 and Laird, 2002). In many cases, only the difference between bound and applied MFN tariffs is studied, as for example in Laird (2002). But the difference between bound and applied tariffs exists due to two components. One is the binding overhang that describes the difference between bound and MFN tariffs according to Francois and Martin (2003). The other is due to the difference between MFN and preferential tariffs (Anderson and Martin, 2006). What is the difference between bound and applied tariffs for different regions of the world, if calculations are based on the TRI or the MTRI? This question is addressed in the following empirical part of this paper. A clarification of this question is particularly interesting for WTO liberalization scenarios, since only the reduction of applied tariffs can induce trade effects.[10]

### A. Tariff Computations

Tables 2a and 2b represent the aggregated tariffs for selected agricultural commodities which are applied in the GTAP simulations. Regions and products are chosen according to the GTAP aggregation that is used in this study. For illustration

[10]This is only when, the reduced applied tariffs are not prohibitive.

**Table 2a.** Aggregated Source Generic Tariffs by GTAP Sector and Region in %

| | Simple average | | | Trade weighted | | | MTRI | | | TRI | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Milk products | | | | | | | | | | | |
| | BT[a] | AT[b] | G-20[c] | BT | AT | G-20 | BT | AT | G-20 | BT | AT | G-20 |
| EU 27 | 60.4 | 37.1 | 20.7 | 36.2 | 26.6 | 16.1 | 36.6 | 26.8 | 16.2 | 45.3 | 32.3 | 20.3 |
| USA | 29.9 | 17.6 | 10.5 | 21.0 | 15.9 | 9.0 | 26.6 | 17.5 | 10.5 | 29.4 | 20.3 | 11.9 |
| Japan | 136.7 | 72.2 | 32.7 | 75.5 | 46.9 | 21.1 | 72.8 | 47.1 | 21.3 | 146.2 | 71.9 | 31.3 |
| Oceania | 9.7 | 1.0 | 1.0 | 12.3 | 1.1 | 1.1 | 13.6 | 1.0 | 1.0 | 18.2 | 1.3 | 1.3 |
| rWTOIC[d] | 144.4 | 62.9 | 30.8 | 128.3 | 61.2 | 30.6 | 164.1 | 80.8 | 39.3 | 199.8 | 106.5 | 48.8 |
| Brazil | 45.8 | 15.7 | 15.6 | 47.3 | 3.7 | 3.7 | 46.6 | 4.7 | 4.7 | 47.0 | 9.7 | 9.7 |
| India | 51.9 | 42.9 | 33.1 | 47.6 | 41.9 | 32.1 | 49.5 | 36.3 | 29.7 | 53.8 | 36.7 | 30.0 |
| ACP | 98.8 | 22.4 | 20.3 | 96.6 | 24.2 | 21.1 | 97.0 | 25.2 | 21.6 | 98.8 | 42.1 | 32.3 |
| LDC | 64.9 | 15.6 | 15.6 | 83.6 | 11.6 | 11.6 | 83.5 | 12.1 | 12.1 | 103.1 | 17.3 | 17.3 |
| rWTODC[e] | 37.4 | 17.6 | 14.2 | 32.0 | 15.5 | 11.9 | 33.3 | 16.3 | 12.5 | 66.0 | 28.0 | 20.7 |
| ROW[f] | n.a. | 15.1 | 15.1 | n.a. | 21.9 | 21.9 | n.a. | 22.7 | 22.7 | n.a. | 29.3 | 29.3 |
| | Cereals | | | | | | | | | | | |
| | BT | AT | G-20 | BT | AT | G-20 | BT | AT | G-20 | BT | AT | G-20 |
| EU 27 | 42.7 | 10.3 | 7.8 | 54.1 | 5.4 | 4.3 | 50.7 | 4.9 | 3.8 | 55.7 | 11.2 | 8.8 |
| USA | 1.5 | 1.0 | 0.6 | 2.3 | 0.1 | 0.0 | 2.5 | 0.1 | 0.1 | 2.7 | 0.5 | 0.3 |
| Japan | 76.5 | 46.3 | 21.7 | 153.5 | 87.3 | 42.9 | 164.3 | 89.9 | 44.6 | 235.9 | 118.2 | 59.7 |
| Oceania | 0.4 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.4 | 0.0 | 0.0 | 0.6 | 0.0 | 0.0 |
| rWTOIC | 86.9 | 43.4 | 21.2 | 57.2 | 32.7 | 13.9 | 73.1 | 34.2 | 14.5 | 120.9 | 68.7 | 28.7 |
| Brazil | 44.7 | 3.4 | 3.4 | 54.0 | 0.4 | 0.4 | 53.7 | 0.4 | 0.4 | 53.8 | 1.5 | 1.5 |
| India | 84.0 | 64.0 | 42.8 | 66.4 | 62.0 | 42.8 | 82.4 | 34.8 | 23.9 | 84.7 | 49.2 | 33.6 |
| ACP | 63.3 | 17.1 | 17.1 | 70.4 | 20.3 | 20.3 | 70.2 | 21.4 | 21.4 | 75.1 | 28.6 | 28.6 |
| LDC | 71.1 | 9.6 | 9.6 | 77.8 | 8.9 | 8.9 | 77.7 | 8.9 | 8.9 | 98.9 | 12.3 | 12.3 |
| rWTODC | 50.1 | 20.4 | 12.5 | 74.4 | 49.8 | 23.3 | 70.5 | 45.9 | 21.7 | 135.4 | 126.2 | 46.7 |
| ROW | n.a. | 5.6 | 5.6 | n.a. | 4.6 | 4.6 | n.a. | 5.0 | 5.0 | n.a. | 9.8 | 9.8 |
| | Beef | | | | | | | | | | | |
| | BT | AT | G-20 | BT | AT | G-20 | BT | AT | G-20 | BT | AT | G-20 |
| EU 27 | 79.4 | 51.7 | 17.9 | 89.4 | 45.8 | 14.9 | 89.3 | 47.1 | 15.4 | 97.0 | 74.7 | 23.1 |
| USA | 4.0 | 1.5 | 1.4 | 9.4 | 2.6 | 2.6 | 9.1 | 2.2 | 2.1 | 9.9 | 3.4 | 3.3 |
| Japan | 42.3 | 41.4 | 14.7 | 44.6 | 44.5 | 19.8 | 44.4 | 44.3 | 19.6 | 52.1 | 51.8 | 21.2 |
| Oceania | 2.1 | 0.2 | 0.2 | 0.4 | 0.0 | 0.0 | 0.4 | 0.0 | 0.0 | 2.3 | 0.3 | 0.3 |
| rWTOIC | 161.3 | 66.9 | 32.7 | 76.0 | 25.7 | 15.9 | 98.7 | 44.7 | 22.2 | 177.5 | 87.4 | 38.8 |
| Brazil | 43.1 | 6.3 | 6.3 | 51.1 | 0.4 | 0.4 | 50.0 | 0.6 | 0.6 | 50.7 | 2.7 | 2.7 |
| India | 100.0 | 35.0 | 35.0 | 100.0 | 35.0 | 35.0 | 100.0 | 35.0 | 35.0 | 100.0 | 35.0 | 35.0 |
| ACP | 95.3 | 12.6 | 12.5 | 104.8 | 16.9 | 16.9 | 122.6 | 12.0 | 11.9 | 130.0 | 19.4 | 19.4 |
| LDC | 60.0 | 16.2 | 16.2 | 50.1 | 13.0 | 13.0 | 50.2 | 13.0 | 13.0 | 60.2 | 16.1 | 16.1 |
| rWTODC | 25.0 | 13.4 | 10.1 | 32.0 | 12.1 | 8.9 | 32.9 | 14.4 | 10.2 | 45.8 | 33.9 | 20.4 |
| ROW | n.a. | 13.0 | 13.0 | n.a. | 13.1 | 13.1 | n.a. | 12.9 | 12.9 | n.a. | 16.3 | 16.3 |

a)BT = initial Bound Tariff, b)AT = initial Applied Tariff, c)G-20 = tariff after the implementation of the G-20 proposal, d)rWTOIC = Rest of all Industrialized WTO member Countries, e)rWTODC = Rest of all Developing WTO member Countries, f)ROW = Rest of the World (non WTO members)
*Source:* Authors' calculations.

**Table 2b.** Aggregated Source Generic Tariffs by GTAP Sector and Region in %

| | Simple average | | | Trade weighted | | | MTRI | | | TRI | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Other Meat Products | | | | | | | | | | | |
| | BT[a] | AT[b] | G-20[c] | BT | AT | G-20 | BT | AT | G-20 | BT | AT | G-20 |
| EU 27 | 20.1 | 13.0 | 7.7 | 29.7 | 23.0 | 11.6 | 28.6 | 22.3 | 11.1 | 35.6 | 28.4 | 13.6 |
| USA | 1.9 | 1.3 | 0.7 | 1.0 | 0.5 | 0.3 | 1.1 | 0.4 | 0.2 | 1.8 | 1.0 | 0.6 |
| Japan | 62.1 | 58.6 | 17.6 | 83.5 | 75.4 | 21.5 | 85.0 | 77.1 | 22.1 | 88.7 | 82.1 | 22.9 |
| Oceania | 8.8 | 2.1 | 2.1 | 3.9 | 0.7 | 0.7 | 2.9 | 0.6 | 0.5 | 5.3 | 1.6 | 1.6 |
| rWTOIC[d] | 144.9 | 58.1 | 24.9 | 41.2 | 21.8 | 10.1 | 57.3 | 27.8 | 12.4 | 234.3 | 62.7 | 24.0 |
| Brazil | 44.0 | 11.1 | 11.1 | 41.4 | 10.5 | 10.5 | 47.5 | 12.7 | 12.7 | 48.5 | 14.1 | 14.1 |
| India | 0.0 | 35.0 | 24.5 | 0.0 | 35.0 | 24.5 | 0.0 | 35.0 | 24.5 | 0.0 | 35.0 | 24.5 |
| ACP | 76.8 | 14.4 | 14.2 | 71.2 | 10.8 | 10.7 | 61.3 | 9.0 | 8.8 | 72.2 | 14.1 | 13.7 |
| LDC | 90.5 | 25.0 | 25.0 | 92.0 | 31.3 | 31.3 | 100.6 | 43.4 | 43.4 | 115.3 | 56.7 | 56.7 |
| rWTODC[e] | 26.8 | 12.8 | 10.5 | 23.4 | 5.1 | 4.4 | 24.6 | 8.6 | 6.9 | 34.6 | 17.0 | 12.9 |
| ROW[f] | n.a. | 16.0 | 16.0 | n.a. | 17.2 | 17.2 | n.a. | 18.2 | 18.2 | n.a | 22.6 | 22.6 |
| | Sugar | | | | | | | | | | | |
| | BT | AT | G-20 | BT | AT | G-20 | BT | AT | G-20 | BT | AT | G-20 |
| EU 27 | 105.9 | 87.4 | 20.6 | 156.8 | 119.1 | 23.6 | 162.6 | 123.0 | 22.7 | 170.8 | 137.2 | 32.2 |
| USA | 41.0 | 22.5 | 11.9 | 50.1 | 27.8 | 15.3 | 51.7 | 26.7 | 15.9 | 55.9 | 32.7 | 18.2 |
| Japan | 246.6 | 229.7 | 63.8 | 292.7 | 277.3 | 74.8 | 298.9 | 282.8 | 76.3 | 305.3 | 293.3 | 77.8 |
| Oceania | 7.4 | 3.0 | 1.6 | 1.4 | 0.3 | 0.1 | 4.2 | 3.6 | 1.7 | 9.2 | 9.3 | 4.3 |
| rWTOIC | 58.5 | 26.1 | 11.5 | 40.2 | 16.9 | 9.6 | 43.1 | 11.4 | 6.3 | 75.7 | 25.4 | 12.3 |
| Brazil | 35.0 | 17.5 | 17.5 | 35.0 | 17.5 | 17.5 | 35.0 | 17.5 | 17.5 | 35.0 | 17.5 | 17.5 |
| India | 125.0 | 43.0 | 43.0 | 138.1 | 53.2 | 53.2 | 138.0 | 53.5 | 53.5 | 139.6 | 54.8 | 54.8 |
| ACP | 100.6 | 37.0 | 32.8 | 103.0 | 14.0 | 13.1 | 104.6 | 4.9 | 4.6 | 104.6 | 16.9 | 15.4 |
| LDC | 87.0 | 20.4 | 20.4 | 112.7 | 19.2 | 19.2 | 93.8 | 22.2 | 22.2 | 110.6 | 27.8 | 27.8 |
| rWTODC | 41.2 | 15.2 | 13.7 | 41.1 | 14.9 | 13.7 | 36.1 | 11.7 | 10.8 | 55.8 | 17.5 | 16.3 |
| ROW | n.a. | 15.3 | 15.3 | n.a. | 12.8 | 12.8 | n.a. | 13.2 | 13.2 | n.a | 23.3 | 23.3 |
| | All Agricultural Products | | | | | | | | | | | |
| | BT | AT | G-20 | BT | AT | G-20 | BT | AT | G-20 | BT | AT | G-20 |
| EU 27 | 19.5 | 12.0 | 6.2 | 26.1 | 14.3 | 6.4 | 27.3 | 15.8 | 6.5 | 49.3 | 38.8 | 12.3 |
| USA | 6.7 | 4.0 | 2.4 | 6.2 | 3.1 | 2.0 | 7.2 | 3.2 | 2.0 | 14.1 | 8.4 | 4.9 |
| Japan | 31.8 | 24.8 | 8.9 | 46.9 | 35.7 | 12.9 | 58.2 | 43.9 | 14.2 | 163.3 | 124.0 | 27.0 |
| Oceania | 6.0 | 1.9 | 1.7 | 5.7 | 1.5 | 1.3 | 5.4 | 1.4 | 1.2 | 8.6 | 2.7 | 2.3 |
| rWTOIC | 51.9 | 20.9 | 10.5 | 37.3 | 15.1 | 8.0 | 43.0 | 18.1 | 9.1 | 99.2 | 44.2 | 19.3 |
| Brazil | 35.1 | 11.2 | 11.0 | 43.0 | 3.6 | 3.6 | 41.9 | 4.3 | 4.3 | 43.8 | 7.8 | 7.7 |
| India | 93.8 | 37.5 | 33.0 | 201.4 | 72.0 | 69.1 | 191.4 | 70.7 | 66.9 | 222.2 | 77.8 | 75.0 |
| ACP | 68.5 | 13.5 | 12.9 | 64.2 | 12.1 | 11.7 | 69.8 | 10.1 | 9.8 | 81.1 | 19.1 | 17.6 |
| LDC | 68.9 | 19.9 | 19.9 | 75.7 | 17.5 | 17.5 | 73.6 | 18.5 | 18.5 | 93.5 | 27.8 | 27.8 |
| rWTODC | 26.9 | 13.4 | 10.7 | 34.6 | 18.4 | 11.1 | 33.4 | 17.6 | 11.0 | 72.3 | 60.9 | 24.0 |
| ROW | n.a. | 17.7 | 17.7 | n.a. | 13.3 | 13.3 | n.a. | 14.1 | 14.1 | n.a | 27.4 | 27.4 |

[a)]BT = initial Bound Tariff, [b)]AT = initial Applied Tariff, [c)]G-20 = tariff after the implementation of the G-20 proposal, [d)]rWTOIC = Rest of all Industrialized WTO member Countries, [e)]rWTODC = Rest of all Developing WTO member Countries, [f)]ROW = Rest of the World (non WTO members)
*Source:* Authors' calculations.

purposes, the three dimensional matrices of the GTAP data base are aggregated into two dimensional arrays. Thus, the tables show only source-generic tariffs. The simple average, the trade weighted average, the MTRI and the TRI are presented for bound and applied tariff rates. The tariff cuts are implemented according to the G-20 proposal as described in Section 3.3. Hence, the reduced source generic tariff is named G-20. The final panel of Table 2b summarizes the results for the agricultural sector as a whole.

Tables 2a and 2b reveal that all aggregation methods lead to a large gap between bound and applied tariff rates. Therefore, some economies with WTO developing country status do not have to reduce their applied tariffs at all. For example, the ACP countries are not forced to reduce their tariffs for cereals. Also, Brazil is allowed to leave tariffs for beef, other meat and sugar unchanged, while India does not have to change its import tariff policies in the sugar and beef sector. Anderson and Martin (2006) explain that due to the ceiling binding option, developing countries were allowed to implement the tariff bindings without reference to former protection levels. As a result, the bound tariffs in developing countries are much higher than in developed countries. Another reason for the large difference between bound and applied tariffs in our study is the consideration of bilateral preferential tariff rates in addition to the MFN tariff rates.

The aggregated tariffs from all four aggregation methods move in the same direction. Expectedly, the correlation coefficient of Pearson and Bravais shows a statistically significant correlation of 0.85 and higher.[11] This result is in accordance with Bureau and Salvatici (2004b) who also found a close relationship between these tariffs when they calculated the trade weighted average tariff and the TRI for the EU and the USA.

In contrast, the level of the aggregated tariffs differs substantially across methods. Depending on the country and product, the simple average tariff exceeds or is below the other aggregation methods. While the results of the trade weighted tariff and the MTRI are similar, the TRI is always higher than these two methods.

According to the underlying theory, the MTRI is always lower than the TRI. This can be explained intuitively. If an initial tariff vector of non-aggregated tariffs is replaced by an aggregated tariff index, lower tariffs will increase and higher tariffs will be reduced. Since the imports must remain constant in the MTRI

[11] The correlation coefficients were calculated for all aggregated tariffs in the GTAP data base. Thus, it is not only based on the sample presented in Table 2a and 2b. All coefficients are statistically significant at the 0.1% level.

calculation, the welfare losses of a tariff increase are less than the welfare gains of a tariff reduction. Consequently, the welfare increases when the MTRI is implemented. A higher tariff is needed to maintain the welfare at its original level. For this reason the TRI is always higher than the MTRI (Anderson and Neary, 2005).[12] This result is reflected in the entries in Tables 2a and 2b.

Anderson and Neary (2005) show theoretically and empirically that the difference between the TRI, the MTRI and the trade weighted tariff is influenced by the variance of the initial tariff structure. According to their regression analysis, the percentage excess of TRI over the MTRI is positively and significantly related to the coefficient of variation of the tariffs. Hence, if there is no variance in the initial structure, and all tariff lines of a sector have identical tariffs, respectively, the same tariff would be calculated by all aggregation methods. In India, for example, all bound tariff lines in the beef sector are fixed at 100 per cent, and all applied tariffs at 35 per cent. Consequently, all aggregation methods show the same aggregated bound and applied tariff rates for this sector.

The import weighted tariff is, in general lower than the equivalence based methods, because the trade weighed tariff assigns high weights to tariffs for products with relatively inelastic demand functions. The influence on the welfare and the trade values is, however, higher, if the import demand function is relatively elastic.

### B. Welfare Effects Computed with GTAP

How is the outcome of the simulations influenced by different tariff aggregation methods? Table 3 reveals the welfare effects of trade liberalization which follow the implementation of the G-20 proposal. The welfare effects are discussed on the basis of the equivalent variation in income expressed in million US $. The main focus of the analysis is on the EU-27.

The columns of Table 3 represent the welfare change as subtotals of market access liberalization, and of the abolishment of export subsidies in different regions of the world. Additionally, a differentiation is made between the impact of agricultural tariff reduction and non-agricultural tariff reduction. The decomposition of the results show how much of the welfare effect stems from liberalization of the EU market and how much is due to the liberalization of third country (TC) markets.[13] The final row of each scenario indicates the sum over all welfare effects

[12]For formal proof of this statement see also Anderson and Neary, 2005, p. 66ff.

[13]We denote all countries except the EU as third countries.

**Table 3.** Welfare Effects of Trade Liberalization According to the G-20 Proposal (2001 US $ millions)

| Scenario | Tariff of agricultural products | | | Tariff of non agricultural products | Export subsidies | | Total |
|---|---|---|---|---|---|---|---|
| | From TC to EU[a)] | From EU to TC[b)] | From TC to TC[c)] | | From EU to TC[d)] | From TC to all regions[e)] | |
| Simple average | Mio. US $ | | | | | | |
| EU-27 | 5759 | 1123 | -556 | 2511 | 10268 | -212 | 18893 |
| Other IC | 946 | 1844 | 9319 | -1006 | -1794 | 43 | 9351 |
| DC | 2281 | 960 | 931 | 19061 | -6403 | -154 | 16676 |
| LDC | -264 | 17 | 124 | 2630 | -829 | -10 | 1669 |
| ROW | 73 | 1 | 188 | 2818 | -1487 | -13 | 1579 |
| World | | | 22745 | 26015 | | -592 | 48168 |
| Trade Weighted | Mio. US $ | | | | | | |
| EU-27 | 8898 | 868 | -39 | 1434 | 10335 | -185 | 21310 |
| Other IC | 568 | 1574 | 8885 | -3575 | -1889 | 4 | 5569 |
| DC | 2344 | 678 | 25570 | 17953 | -5206 | -186 | 41153 |
| LDC | -366 | 26 | 506 | 3349 | -799 | -11 | 2705 |
| ROW | 13 | -11 | 59 | 2781 | -1526 | -12 | 1305 |
| World | | | 49574 | 21942 | | 526 | 72041 |
| MTRI | Mio. US $ | | | | | | |
| EU-27 | 9002 | 977 | -181 | 1712 | 10284 | -190 | 21604 |
| Other IC | 691 | 1898 | 12507 | -3198 | -2041 | -8 | 9849 |
| DC | 2297 | 800 | 23786 | 19900 | -5476 | -179 | 41128 |
| LDC | -378 | 30 | 486 | 3528 | -827 | -11 | 2828 |
| ROW | 19 | -9 | 28 | 2735 | -1532 | -12 | 1227 |
| World | | | 51951 | 24676 | | 7 | 76635 |
| TRI | Mio. US $ | | | | | | |
| EU-27 | 10382 | 2046 | 762 | 6494 | 9761 | -224 | 29220 |
| Other IC | 1190 | 3498 | 40536 | -1405 | -2575 | -49 | 41197 |
| DC | 3264 | 2059 | 56408 | 120939 | -6840 | -223 | 175607 |
| LDC | -456 | 57 | 894 | 5441 | -897 | -12 | 5026 |
| ROW | 82 | -7 | 210 | 3230 | -1615 | -15 | 1884 |
| World | | | 120925 | 134699 | | -2689 | 252934 |

[a)]The effect of tariff liberalization of the EU on products coming from Third Countries (TCs)
[b)]The effect of tariff liberalization of TCs on products coming from the EU
[c)]The effect of tariff liberalization of TCs on products coming from other TCs
[d)]The effect of the abolishment of EU export subsidies
[f)]The effect of the abolishment of TCs export subsidies
*Source:* Authors' calculations.

of each pillar.

Simple average tariffs result in an increase in the world's welfare of $ 48.2 billion. Thereby, the EU-27 and other industrialized countries obtain 59 per cent of the welfare gains, while developing countries and LDCs get 38 per cent of these gains. The remaining 3 per cent are distributed to non WTO member countries (ROW). These countries participate in the gains from trade liberalization through the terms of trade effect.

Agricultural tariff reductions contribute with $ 22.7 billion and non agricultural tariff reduction with $ 26 billion to the overall welfare gain. While most of the gains from agricultural trade liberalization go to industrialized countries, 83 per cent of the welfare gains from non agricultural trade liberalization can be gathered by WTO developing countries and LDCs. This result is due to relatively high import tariffs for manufactures in many developing countries in the initial situation.

The overall welfare effect of the export subsidy abolishment is small compared to the gains induced by the reduction of import tariffs. But the decomposition shows that there is a wide margin of results which offset one another and lead to a small overall effect. In most economies, especially in developing countries, the elimination of export subsidies leads to a welfare loss. The abolishment reduces the supply of agricultural products on the world market. Consequently, the world market prices rise and net food importing countries suffer from higher prices. The EU-27 pays most of these subsidies and expectedly shows welfare gains of around $ 10.3 billion due to the terms of trade and the allocation effect following the abolishment of this trade distorting instrument. These results do not change significantly in the other three scenarios.

The implementation of the trade weighted average tariff generates a larger increase in welfare, totaling $ 72 billion for the world as a whole. In contrast to the previous scenario, developing countries and LDCs receive 61 per cent of these global welfare gains, while the industrialized countries only receive 37 per cent. The ROW gets 2 per cent of the gains because of the terms of trade effect through non agricultural trade liberalization.

The reduction of agricultural tariffs contributes with more than two thirds, or $ 49.6 billion, to the overall welfare gain. Developing countries retain about $ 28.6 billion of these gains which come mainly from market access liberalization between third countries ($ 25.6 billion). A more detailed examination shows that most of the gains for developing countries are generated by liberalization of their own agricultural markets. The difference between the simple average tariff and the trade weighted average scenario can be attributed to the welfare effects of developing countries that arise from tariff reduction between third countries. The data base shows that the trade weighted tariffs exceed the simple average tariff, especially in the cereal and oil seed sector of WTO developing countries. Despite the high tariffs, these products generate a high trade value. Here the simple average tariff smooth out high tariffs for products with high trade value. Initially, this appears to contradict the findings of Yu (2006), who concluded that the trade weighted average tariff understates the effect of preference erosion for African LDCs.[14] But our results are highly driven by the effects of trade liberalization between developing countries. While preference erosion can be understated with the trade weighted average tariff, this effect does not compensate the total welfare effects of multilateral trade liberalization if the simple average tariff is applied to the complete data base of the GTAP model.

If the MTRI is used as tariff aggregation measure, the overall welfare gains increase a bit more, to $ 76.6 billion. The distribution of welfare gains between industrialized economies (41 per cent) and the group of developing countries including LDCs (57 per cent) is similar to the previous scenario.

The reduction of agricultural and non agricultural tariff distortions generates $ 52 billion and $ 24.7 billion, respectively, for the world as a whole. Half of the welfare gains from tariff reduction are collected by developing countries.

Compared to the trade weighted average scenario, particularly the benefits of trade liberalization increase in other industrialized economies. Developing countries show a higher increase in welfare for non agricultural products than in the trade weighted average scenario. However, the effect of agricultural tariff reduction differs only slightly between both scenarios for all economies.

The TRI scenario predicts an overall welfare gain of $ 252.9 billion which is more than three times as high as in the trade weighted average and the MTRI scenario, and more than five times as high as in the simple average scenario. Industrialized countries receive 28 per cent of these gains, while developing economies and the LDCs obtain 71 per cent.

The welfare gains for developing countries amount to $ 120.9 billion from non agricultural market liberalization. In contrast, the terms of trade for other industrialized countries worsen, so that the welfare effect of non agricultural

[14] If a tariff line is recorded for one African LDC (country A) but not for another (country B) he transferred that line to country B because it might be an applicable rate for B, when B starts to export that product.

market liberalization becomes negative. However, other industrialized countries obtain $ 45.2 billion through the reduction of agricultural import tariffs. Accordingly, their overall welfare gain adds up to $ 41.2 billion.

The welfare effect following the abolishment of export subsidies is negative in this scenario. The terms of trade effect is more evident due to the higher import tariffs in the initial situation, and welfare decreases in all countries except the EU-27.

The initial tariffs are much higher in the TRI scenario, as compared to the other three scenarios. Thus, a reduction of these high initial tariffs according to the G-20 proposal in the agricultural sector, and the proportional tariff cut in the non agricultural sector, results in higher welfare effects. Most of the additional gains can, however, be attributed to the reduction of the non agricultural tariffs because the trade value of the manufacturing sector is much higher than that of the agricultural sector.

In sum, the reduction based on the TRI expectedly results in higher welfare gains for single country groups and the whole world than the reduction based on trade weighted tariffs. How does this relate to the studies already available on trade liberalization? Most of the more recent studies on trade liberalization show lower welfare results than the earlier ones. The reasons are, for example, the improvement of data bases through the inclusion of preferential tariffs which leads to a lower initial protection level. Additionally, it has to be taken into account that some liberalization has already occurred in the meantime. However, this study shows that the welfare effects depend highly on the chosen tariff aggregation method. Most recent studies use simple averages or trade weights for tariff aggregation and thus might still underestimate the welfare changes of trade liberalization.

The analysis presented here shows how much, and in which direction, the welfare effects of a trade model can be influenced by different aggregation methods. For future research it would be valuable to include some sensitivity analysis on the import demand elasticities employed in aggregation. Another key practical issue pertains to the treatment of missing data.

## V. Conclusion

It is well known from the literature that the tariff data base of a model can significantly influence the results of liberalization studies. An essential prerequisite for the applied policy analysis is thus a consistent and transparent tariff data base.

The MAcMap data base presents a very important development in this context. It connects the data bases AMAD, TRAINS, WTO and COMTRADE with each other and with information from national sources. It also includes bound and applied tariffs with consistent conversion of the specific tariffs in AVEs up to the HS6-digit tariff line level.

The results of a liberalization study could, however, also be influenced through the aggregation of the tariff data to a model compatible level. Different methods are available for the aggregation of import tariffs. Usually the simple and the trade weighted average tariff are implemented. The advantage of these two methods is the comparably low data requirements. However, these methods are not based on economic theory. Anderson and Neary (1994, 2003), in contrast, developed two theoretically sound aggregation methods. These are the TRI (Trade Restrictiveness Index), allowing for a welfare equivalent aggregation of the tariffs, and the MTRI (Mercantilist Trade Restrictiveness Index), with the help of which the tariffs can be aggregated to an import equivalent tariff. These indices place high requirements on the data used for this purpose, which can in many cases not be fulfilled. If simplifying assumptions are made, it is, however, possible to calculate these indices with the already existing data for the whole import tariff data base of a trade model.

In this paper we built simple and trade weighted average tariffs as well as TRIs and MTRIs from the HS6-digit tariff line level to the level of the GTAP model. The results show a high difference between bound and applied tariff rates for all aggregation methods. The gap between both tariffs arises for developed, and to a greater extent, for developing countries. Therefore, if the G-20 proposal of the WTO negotiations is applied, some countries do not have to reduce their applied tariffs in some sectors at all.

Analysis of the aggregated bound and applied tariff rates reveals a significant correlation between all aggregation methods. The level of the tariff aggregates can still be very different though. While the simple average shows the lowest tariff aggregates, especially for developing countries, the trade weighted average tariff and the MTRI are very similar and the TRI results in the highest tariffs.

The welfare results of the simulations with the GTAP model mirror these findings. The simple average tariff results in the lowest welfare gains from trade liberalization. Additionally, it can be shown that the trade weighted average tariff is a good approximation of the theoretically sound MTRI. The welfare effect of the TRI scenario, in contrast, exceeds these results by more than three times. Also, the share of welfare effects changes due to agricultural or manufacturing trade liberalization. In the simple average scenario, the welfare effect of the tariff reduction in the manufacturing sector slightly exceeds the welfare effects of the agricultural trade liberalization. Approximately two thirds of the welfare gains arise from agricultural trade liberalization if the trade weighted tariff or the MTRI is applied. In contrast, manufacturing trade liberalization becomes most important if the TRI is applied. However, this analysis shows that welfare results are highly dependent on the chosen aggregation method. If the TRI is assumed to be the most appropriate aggregation measure, welfare effects are likely to be dramatically underestimated with trade weighted tariffs.

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