Methods to Aggregate Import Tariffs and their Impacts on Modeling Results

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Abstract

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 6-digit tariff line level with 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.

Keywords:

Import tariff aggregation, tariff cutting scenarios, bound and applied tariffs, WTO negotiations, CGE modeling, agricultural trade policy

JEL classification:

F13, F17, Q17

1 Introduction

It is a great challenge for economists to predict the impact of multilateral trade liberalization. A study by UNCTAD (2003), for example shows that the results of welfare effects of liberalization studies can vary widely. This may be attributed to the type of model (partial or general, static or dynamic), the calculated scenarios or the chosen parameters. Furthermore, the data bases used are heterogeneous and lead to divergences in each of the model results (Hess and Cramon-Taubadel, 2006).

In the measurement of trade protection, possibilities for distortion exist on two levels. First the protection can appear in many variations: there are tariffs as well as non tariff trade barriers. Import tariffs can be expressed in value terms (ad valorem), as specific and compound tariffs, or in the form of tariff rate quotas (TRQs). In order to compare the various instruments, they must be transferred into a common metric. For this, however, no "perfect" solution exists (Cipollina and Salvatici, 2006). In most data bases, the policy instruments are thus converted into ad valorem equivalents (AVEs). But distortions emerge due to this transformation as well. Salamon (2006), for example, shows for milk that the conversion of specific tariffs into AVEs strongly depends on the basis year used.

Secondly, the aggregation of the data base also leads to distortions. 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 in the models are, however, available at a much 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).

Anderson and Neary (1994, 2003) developed two theory-based indices: the Trade Restrictiveness Index (TRI) and the Mercantilist Trade Restrictiveness Index (MRTI). While the first index measures the uniform welfare equivalent trade restriction, the second index is an import volume equivalent method. There is a body of growing literature on these indexes. In some studies these indices are calculated in a general equilibrium framework. Others use a partial equilibrium approach.

In this paper we concentrate on the TRI and MTRI and their application in modeling. For this purpose, Chapter Two of this paper describes the theory of the implemented tariff aggregation methods and gives a short overview of the current literature on this topic. In Chapter Three a simple, partial equilibrium calculation of the TRI and the MTRI is applied to aggregate tariffs from the 6-digit tariff line level to the level of the Global Trade Analysis Project (GTAP) model. Taking import demand elasticities from the literature and using the MAcMap and COMTRADE data base, we calculate aggregated bound and applied import tariffs. The results are then compared with the tariffs derived by trade weighting.

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? To answer these questions import tariffs aggregated with the help of the TRI and MTRI are additionally substituted for the original applied import tariffs of the standard GTAP data base. A multilateral trade liberalization scenario according to the G-20 proposal (October 2005) is then implemented at the tariff line level. For each scenario bound and applied tariffs are taken into account. Finally the modeling results are compared by considering the welfare effects. Thereby, the focus of the discussion is on the EU-27. The results are discussed in Chapter Four. The paper ends with a conclusion.

2 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 trade weighted average tariff, the TRI and the MTRI are applied. Therefore, only these three methods are discussed in the theoretical part of this paper. For a broader discussion of tariff aggregators see Cipollina and Salvatici (2006).

2.1 Trade Weighted Average Tariffs

The tariff aggregation based on the weighting of the import values is the most commonly used aggregation method in modeling (Manole and Martin, 2005). Employing this method the aggregated tariff t_{agg} is calculated as a weighted average of the ad valorem tariffs t_i for good i $(i=1,\ldots,.n)$:[1]

$$(1) \qquad t_{Agg} = \sum_{i=1}^{n} w_i^* \cdot t_i$$

The weight w_i^* is thereby based on the import quantity q_i and the world market price p_{wi}:

$$(2) \qquad w_i^* = \frac{q_i \cdot p_{wi}}{\sum_{i=1}^{n} q_i \cdot p_{wi}}$$

This method considers the relative importance of trade flows. The greater the importance of a product for trade, the greater is 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[2] Software (World Integrated Trade Solution) from the COMTRADE data base[3]. 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 disproportionately highly 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

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1 For the sake of simplicity we only consider one product group in this equation and abstract from regional aggregation.

2 cf.: http://wits.worldbank.org/witsweb/default.aspx

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

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 with which an attempt is made to minimize the endogenous bias of the import weighting. For example, Bouët et al. (2004) propose a weighting based on reference groups. Here it is assumed that the import structure of similar countries is a proxy for the free trade structure of a given country. The weighted import value *V** is calculated using the import values of the reference groups (RefGrp):

$$(3) \qquad V^*_{i\ r\ s} = V_{i\ r\ \mathit{RefGrp}} \frac{\sum_{i=1}^{n}\sum_{r=1}^{m} V_{i\ r\ s}}{\sum_{i=1}^{n}\sum_{r=1}^{m} V_{i\ r\ \mathit{RefGrp}}}$$

$V_{i\ r\ ReGrp(s)}$ refers to the value of product *i* imported by the reference group of country *s* from country *r*. The second term of the equation presents a normalization factor, with which the share of the total imports of a country s are given in proportion of the total imports of the reference group. Thus, that the size of the reference group does not influence the results. The aggregated tariffs are then calculated according to the Formula (1) where $w^*_{i\ r\ s}$ is defined as

$$(4) \qquad w^*_{i\ r\ s} = \frac{V^*_{i\ r\ s}}{\sum_{i=1}^{n} V^*_{i\ r\ s}}$$

In the literature, the weighing of tariffs with non-distorted values is often presented as a preferable aggregation method. The OECD (1997), for example, describes a weighting via the value of the imports or the production without trade barriers as ideal. Leamer (1974) proposes a model in which duty free import values are estimated with a function of the variables GNP, population and endowment of resources. These calculated import values are used for the weighing of tariffs to make a consistent weighing possible. Anderson and Neary (2005) show however, that weighting with the undistorted import values can reduce the endogenous bias. In contrast, a correct presentation of welfare and traded quantities is not given, since import demand elasticities are not considered. Another disadvantage of this method is that the import values under free trade are hard to measure. To correctly estimate the weights, much more information would be needed and a complete import demand model would have to be specified and estimated.

2.2 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. According to Kee at al. (2005b), it therefore answers the question: What is the uniform tariff that would keep welfare constant?

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 partially (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 HS-8 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 HS-6 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 HS-8 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 4-digit tariff line level.

In contrast to the trade weighted tariff, the TRI is theoretically based. Different studies show, however, that various simplifying assumptions must be accepted to empirically calculate the TRI. Particularly a lack of data availability at the HS-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 is very restrictive and 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.

2.3 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 at world market prices as the initial vector of non-aggregated tariffs (Anderson and Neary, 2003). Thus, the index measures the uniform tariff which keeps imports constant (Corden, 1966).

Analogously, 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 HS-4 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 HS-6 level and aggregate them to the source and product generic country level. Therefore, they show only one supra-sector aggregated tariff per country.

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

In the partial equilibrium application it also holds true for the MTRI that no intersectoral effects are documented and the assumption of a small country works restrictively.

3 Methodology

This chapter describes how the empirical results of this paper are generated. The underlying formulas for the TRI and the MTRI are deviated and the data set is specified. Finally, the extension of the GTAP model and the implemented scenarios are described.

3.1 Empirical Estimation of the TRI and MTRI

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 a linear import demand curve given below:

(5) $$q_i = a_i - b_i \cdot p_i$$

Where the constant *a* stands for the point at which the demand curve of product *i* intersects the ordinate and *b* describes the slope of the demand curve. At the price p_i the quantity demanded of product *i* is q_i. The welfare loss (W_i) arising from an import tariff, can be formally presented as:

(6) $$W_i = \int_0^{p_{di}} q_i dp_i - \int_0^{p_{wi}} q_i dp_i - q_{di} \cdot (p_{di} - p_{wi})$$

$$= (a_i \cdot p_{di} - 0.5 b_i \cdot p_{di}^2) - (a_i \cdot p_{wi} - 0.5 b_i \cdot p_{wi}^2) - (a_i - b_i p_{di}(p_{di} - p_{wi}))$$

p_{wi} world market price of product *i*

p_{di} domestic price of product *i* , $p_{di} = p_{wi} + p_{wi} \cdot t_i$

Rearranging the expression in equation (6) results in the following term:

$$(7)\qquad W_i = \frac{(t_i \cdot p_{wi})^2 \cdot b_i}{2}$$

The total welfare loss of a given country can be expressed as $\sum W_i = W$, so that the welfare equivalent tariff Δt_{TRI} is expressed implicitly with the following equation:

$$(8)\qquad \sum_{i=1}^{n} [(\Delta t_{TRI} \cdot p_{wi})^2 \cdot b_i] = \sum_{i=1}^{n} [(t_i \cdot p_{wi})^2 \cdot b_i]$$

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 (8) results in equation (9):

$$(9)\qquad \Delta t_{TRI} = \left(\sum_{i=1}^{n} \left[\frac{\varepsilon_i \cdot w_i^*}{\sum_{i=1}^{n} [\varepsilon_i \cdot w_i^*]} \cdot t_i^2 \right] \right)^{0.5}$$

The MRTI *(Δt_{MTRI})* is calculated based on a concept of 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 (10):

$$(10)\qquad \sum_{i=1}^{n} \left[p_{wi} \cdot [a_i - b_i \cdot (1 + \Delta t_{MTRI}) \cdot p_{wi}] \right] = \sum_{i=1}^{n} \left[p_{wi} \cdot [a_i - b_i \cdot (1 + t_i) \cdot p_{wi}] \right]$$

The left hand side of the equation describes the total value of imports that is 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 (10) the following equation can be derived:

$$(11)\ \ \Delta t_{MTRI} = \sum_{i=1}^{n} \left[\frac{\varepsilon_i \cdot w_i^*}{\sum_{i=1}^{n} [\, \varepsilon_i \cdot w_i^* \,]} \cdot t_i \right]$$

Equations (9) and (11) serve to calculate the TRI and the MTRI in the empirical part of this article. The sum over different regions has to be calculated in addition to the sum over different products in many of the empirical analysis cases.

3.2 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 average tariff only includes 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[4] (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 %, the tariff is used within the quota. If the fill rate

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

is greater than 100 % in contrast, the out of quota tariff is implemented. Should the filling rate be between 90 % and 100 %, a simple average of the in and out quota tariff is created (Bouët et al., 2004).

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 in concordance with the model simulations.

The import demand elasticities used are estimated by Kee et al. (2005a) at the 6-digit tariff line level with a semi-flexible translog function. 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 being used more frequently to estimate such elasticities (Kee et al., 2005a).

3.3 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 multi regional general equilibrium GTAP model[5] is applied.

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

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 political intervention in the EU-15 and in the 12 candidate countries. Developments in other regions, like the Farm Bill of the USA or China's WTO access, are not yet taken into account. Parallel to the base run, a scenario 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. This final step is in the centre of 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 % and 33 % in the developed and developing countries[6], respectively. Least Developed Countries (LDCs) are exempted from tariff reductions in all scenarios.

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

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	75,00	>130	40,00
>50 ≤ 75	65,00	>80 ≤ 130	35,00
>20 ≤ 50	55,00	>30 ≤ 80	30,00
0 ≤ 20	45,00	0 ≤ 30	25,00
Cap: 100 %		Cap: 150 %	

Source: G-20 (2005).

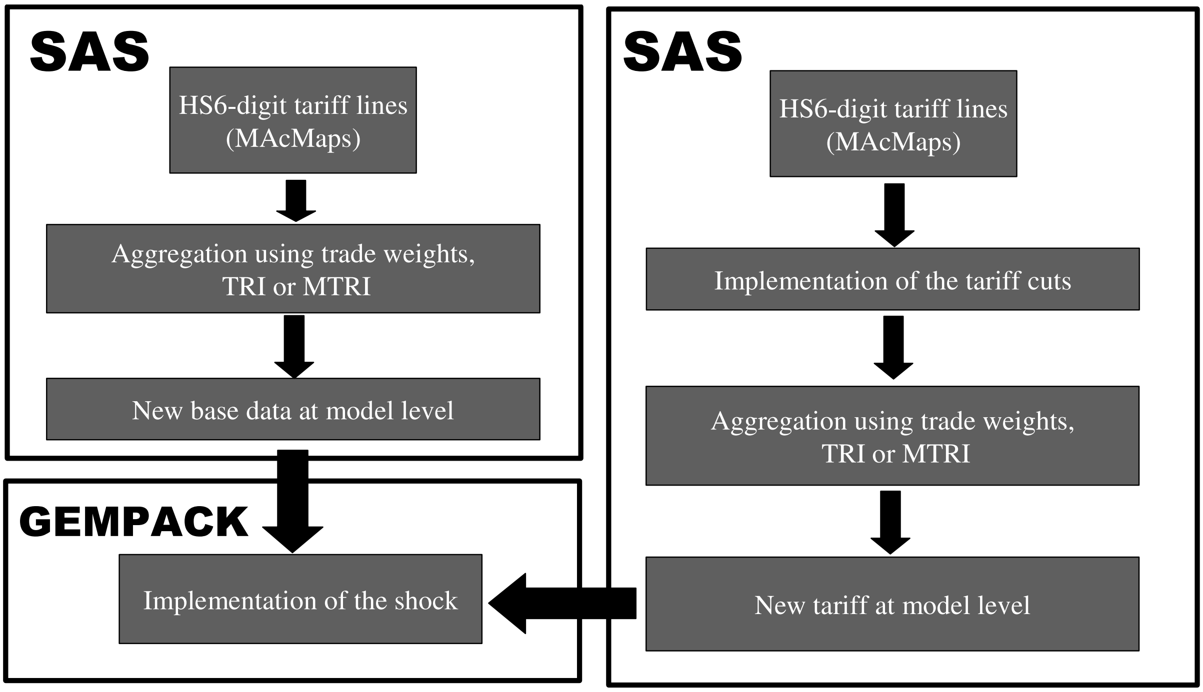
Agricultural export subsidies are also eliminated in all scenarios. For the domestic support pillar, we follow the assessment of Brink (2006) and Blandfort (2005) that neither of the currently available proposals will highly constrain domestic support. Therefore, domestic support is kept unchanged for all countries and regions in all scenarios.

In total, three scenarios are conducted by employing different aggregation methods based on the 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. Therefore, a program is developed applying the Statistical Analysis Software (SAS).

Figure 1 shows how the tariffs are calculated for each scenario. Both the initial base data and the reduced tariffs are generated from the 6-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. After this the GTAP data base contains the new applied tariffs at the base level.

In a second step, the data are cut at the 6-digit tariff line level in the data base. Thereby, bound and applied tariffs are taken into account. 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 of the tariff rate before and after the cut.

Figure 1: Calculation of the Base Data and the Tariff Cuts by Different Aggregation Measures



4 Results

In Chapter 2 it is 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) only concentrate on the applied tariff. Until now there has been no study in which bound and applied tariffs for the calculation of the TRIs or the MTRIs are considered.

Anderson and Martin (2005) describe 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 because of 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, 2005). 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[7].

4.1 Tariffs Computed with SAS

Table 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 (see Appendix A1.1 and A1.2). For illustration purposes the three dimensional matrices of the GTAP data base are aggregated into two dimensional arrays. Thus, the tables only show source generic tariffs. 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 Chapter 3.3. Hence, the reduced source generic tariff is named G-20. The last rows of Table 2b summarize the results for the agricultural sector as a whole. Here, the source and product generic tariffs are presented.

Tables 2a and 2b reveal that all aggregation methods lead to a high 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 their import tariff policies in the sugar and beef sector. One reason for the high difference between bound and

7 This is only when, the reduced applied tariffs are not prohibitive.

applied tariffs in this study is the consideration of bilateral preferential tariff rates in addition to the MFN rates.

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

	Trade weighted			MTRI			TRI		
	Milk products								
	BT[a]	AT[b]	G-20[c]	BT	AT	G-20	BT	AT	G-20
EU 27	36.2	26.6	16.1	36.6	26.8	16.2	45.3	32.3	20.3
USA	21.0	15.9	9.0	26.6	17.5	10.5	29.4	20.3	11.9
Japan	75.5	46.9	21.1	72.8	47.1	21.3	146.2	71.9	31.3
Oceania	12.3	1.1	1.1	13.6	1.0	1.0	18.2	1.3	1.3
rWTOIC[d]	128.3	61.2	30.6	164.1	80.8	39.3	199.8	106.5	48.8
Brazil	47.3	3.7	3.7	46.6	4.7	4.7	47.0	9.7	9.7
India	47.6	41.9	32.1	49.5	36.3	29.7	53.8	36.7	30.0
ACP	96.6	24.2	21.1	97.0	25.2	21.6	98.8	42.1	32.3
LDC	83.6	11.6	11.6	83.5	12.1	12.1	103.1	17.3	17.3
rWTODC[e]	32.0	15.5	11.9	33.3	16.3	12.5	66.0	28.0	20.7
ROW[f]	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
EU 27	54.1	5.4	4.3	50.7	4.9	3.8	55.7	11.2	8.8
USA	2.3	0.1	0.0	2.5	0.1	0.1	2.7	0.5	0.3
Japan	153.5	87.3	42.9	164.3	89.9	44.6	235.9	118.2	59.7
Oceania	0.1	0.0	0.0	0.4	0.0	0.0	0.6	0.0	0.0
rWTOIC	57.2	32.7	13.9	73.1	34.2	14.5	120.9	68.7	28.7
Brazil	54.0	0.4	0.4	53.7	0.4	0.4	53.8	1.5	1.5
India	66.4	62.0	42.8	82.4	34.8	23.9	84.7	49.2	33.6
ACP	70.4	20.3	20.3	70.2	21.4	21.4	75.1	28.6	28.6
LDC	77.8	8.9	8.9	77.7	8.9	8.9	98.9	12.3	12.3
rWTODC	74.4	49.8	23.3	70.5	45.9	21.7	135.4	126.2	46.7
ROW	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
EU 27	89.4	45.8	14.9	89.3	47.1	15.4	97.0	74.7	23.1
USA	9.4	2.6	2.6	9.1	2.2	2.1	9.9	3.4	3.3
Japan	44.6	44.5	19.8	44.4	44.3	19.6	52.1	51.8	21.2
Oceania	0.4	0.0	0.0	0.4	0.0	0.0	2.3	0.3	0.3
rWTOIC	76.0	25.7	15.9	98.7	44.7	22.2	177.5	87.4	38.8
Brazil	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
ACP	104.8	16.9	16.9	122.6	12.0	11.9	130.0	19.4	19.4
LDC	50.1	13.0	13.0	50.2	13.0	13.0	60.2	16.1	16.1
rWTODC	32.0	12.1	8.9	32.9	14.4	10.2	45.8	33.9	20.4
ROW	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 %

	´Trade weighted			MTRI			TRI		
	Other Meat Products								
	BT[a]	AT[b]	G-20[c]	BT	AT	G-20	BT	AT	G-20
EU 27	29.7	23.0	11.6	28.6	22.3	11.1	35.6	28.4	13.6
USA	1.0	0.5	0.3	1.1	0.4	0.2	1.8	1.0	0.6
Japan	83.5	75.4	21.5	85.0	77.1	22.1	88.7	82.1	22.9
Oceania	3.9	0.7	0.7	2.9	0.6	0.5	5.3	1.6	1.6
rWTOIC[d]	41.2	21.8	10.1	57.3	27.8	12.4	234.3	62.7	24.0
Brazil	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
ACP	71.2	10.8	10.7	61.3	9.0	8.8	72.2	14.1	13.7
LDC	92.0	31.3	31.3	100.6	43.4	43.4	115.3	56.7	56.7
rWTODC[e]	23.4	5.1	4.4	24.6	8.6	6.9	34.6	17.0	12.9
ROW[f]	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
EU 27	156.8	119.1	23.6	162.6	123.0	22.7	170.8	137.2	32.2
USA	50.1	27.8	15.3	51.7	26.7	15.9	55.9	32.7	18.2
Japan	292.7	277.3	74.8	298.9	282.8	76.3	305.3	293.3	77.8
Oceania	1.4	0.3	0.1	4.2	3.6	1.7	9.2	9.3	4.3
rWTOIC	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
India	138.1	53.2	53.2	138.0	53.5	53.5	139.6	54.8	54.8
ACP	103.0	14.0	13.1	104.6	4.9	4.6	104.6	16.9	15.4
LDC	112.7	19.2	19.2	93.8	22.2	22.2	110.6	27.8	27.8
rWTODC	41.1	14.9	13.7	36.1	11.7	10.8	55.8	17.5	16.3
ROW	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
EU 27	26.1	14.3	6.4	27.3	15.8	6.5	49.3	38.8	12.3
USA	6.2	3.1	2.0	7.2	3.2	2.0	14.1	8.4	4.9
Japan	46.9	35.7	12.9	58.2	43.9	14.2	163.3	124.0	27.0
Oceania	5.7	1.5	1.3	5.4	1.4	1.2	8.6	2.7	2.3
rWTOIC	37.3	15.1	8.0	43.0	18.1	9.1	99.2	44.2	19.3
Brazil	43.0	3.6	3.6	41.9	4.3	4.3	43.8	7.8	7.7
India	201.4	72.0	69.1	191.4	70.7	66.9	222.2	77.8	75.0
ACP	64.2	12.1	11.7	69.8	10.1	9.8	81.1	19.1	17.6
LDC	75.7	17.5	17.5	73.6	18.5	18.5	93.5	27.8	27.8
rWTODC	34.6	18.4	11.1	33.4	17.6	11.0	72.3	60.9	24.0
ROW	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.

The results of the trade weighted average and the two equivalence indices are close to each other. Expectedly, the correlation coefficient according to Pearson and Bravais shows a statistically significant correlation between all methods (compare Table 3). 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.

Table 3: Correlation coefficient according to Pearson and Bravais for the different aggregation methods[a]

Correlation of:	Bound tariffs	Applied tariffs	G-20
Import weighted and MTRI	0.996*	0.997*	0.986*
Import weighted and TRI	0.852*	0.960*	0.945*
MTRI and TRI	0.858*	0.955*	0.959*

a) The table shows the correlation coefficients for aggregates of all tariffs which are used in the GTAP data base (including non agricultural products). It is not only based on the sample presented in Table 2a and 2b. The * denotes that coefficients are statistically significant at the 0.1 % level.

Source: Authors' calculations.

Furthermore, Anderson and Neary (2005) show in a theoretical and empirical analysis that the difference between the TRI and the import weighted tariff is influenced by the variance of the initial tariff structure. According to their regression analysis, the percentage excess of TRI over the trade weighted tariff 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 % and all applied tariffs at 35 %. 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. This is considered in the TRI or MTRI and leads to a further deviations between the indices.

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, then the lower tariffs increase and higher tariffs are reduced. Since the import volumes or values must remain constant in the MTRI 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)[8].

4.2 Welfare Effects Computed with GTAP

How is the outcome of the simulations influenced by different tariff aggregation measures? Table 4 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 4 represent the welfare change as subtotals of market access liberalization and of the abolishment of export subsidies in different regions of the world. Additionally, it is differentiated 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 liberali-

8 For formal proof of this statement see also ANDERSON and NEARY, 2005, p. 66ff.

zation of third country markets. The final row of each scenario indicates the sum over all welfare effects of each pillar.

The implementation of the trade weighted average tariff generates an increase in welfare of \$ 72 billion for the world. Developing countries and LDCs receive 60 % of these global welfare gains, while the industrialized countries only receive 37 %. The remaining 3 % are distributed to non WTO member countries (ROW). They are participating in the gains from non agricultural trade liberalization because of the terms of trade effect.

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 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 compensate each other 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 is paying most of these subsidies and expectedly shows welfare gains of around \$ 10 billion due to the terms of trade and the allocation effect following the abolishment of this trade distorting instrument.

Table 4: Welfare Effects of Trade Liberalization According to the G-20 Proposal (2001 US$ millions)

Scenario	Tariff of agricultural products from TC[a)] to EU	Tariff of agricultural products from EU to TC	Tariff of agricultural products From TC To TC	Tariff of non agricultural products	Export subsidies from EU to TC	Export subsidies From TC to all regions	World
Weighted				**Mio. $**			
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
total			**49574**	**21942**		**526**	**72041**
MTRI				**Mio. $**			
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
total			**51951**	**24676**		**7**	**76635**
TRI				**Mio. $**			
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
total			**120925**	**134699**		**-2689**	**252934**

a) TC = Third Countries

Source: Authors' calculations.

If the MTRI is used as tariff aggregation measure, the overall welfare gains increase to $ 76.6 billion. The distribution of welfare gains between industrialized economies (41 %) and the group of developing countries including LDCs (57 %) 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 gain from tariff reduction is collected by developing countries.

Compared to the first scenario, the benefits of trade liberalization particularly increase in industrialized economies. Thus, the implementation of the G-20 proposal on import equivalent tariffs induces higher overall welfare results in the EU and other industrialized countries. Developing countries show a higher increase in welfare for non agricultural products than in the first scenario. However, the effect of agricultural tariff reduction differs only slightly between both scenarios for these economies.

The TRI scenario predicts an overall welfare gain of $ 252.9 billion which is more than twice as high as in the two other scenarios. Industrialized countries are receiving 28 % of these gains, while developing economies and the LDCs are obtaining 71 %.

Developing countries receive $ 120.9 billion of the welfare gains from non agricultural market liberalization. In contrast, the terms of trade for other industrialized countries worsens, so that the welfare effect of non agricultural 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 compared to the other two scenarios, when the TRI is implemented as tariff aggregation measure. 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 cuts and therefore also in higher welfare effects. Most of the additional gains can, however, be attributed to the reduction of the non agricultural tariffs. Therefore, it is not surprising that the reduction of welfare equivalent tariffs leads to a high welfare gain. In addition to the aforementioned reason 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 already available studies 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 in the meantime some liberalization has already occurred. However, this study shows that the welfare effects highly depend on the chosen tariff aggregation method. All recent studies only use trade weights as aggregation methods and might thus 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 interesting to include some sensitivity analysis on the employed import demand elasticities. Here, only trade data are considered for which elasticities exist. How to deal with missing data is another research question which would be interesting to address in future research.

5 Conclusion

It is well known from the literature that the tariff data base of a model can influence the results of liberalization studies significantly. An essential prerequisite for the applied policy analysis is thus a consistent and transparent tariff data base. The MAcMap data base (Bouët et al., 2004) therefore presents a very important development in this context. It connects the data bases AMAD, TRAINS, WTO and COMTRADE as well as information from national sources. It also includes bound and applied tariffs with consistent conversion of the specific tariffs in AVEs up to the 6-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 tariff data. 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 do not base on a 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 import volume equivalent. 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 aggregate tariff data with the help of import weights and based on the TRI and MTRI from the 6-digit tariff line level to 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 extend 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 of 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 trade weighted average tariff and the MTRI are very similar, the TRI is much higher. Furthermore, the empirical analysis shows in accordance with the underlining theory that there is a high correlation between the variance of the initial tariff structure and the difference between the trade weighted average and the MTRI with the TRI.

The welfare results of the simulations with the GTAP model mirror these findings. 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 due to agricultural or manufacturing trade liberalization changes. Approximately two thirds of the welfare gains arise from agricultural trade liberalization, if the trade weighted of the MTRI is applied. In contrast, if the TRI is applied manufacturing trade liberalization becomes most important.

However, this analysis shows that welfare results are highly dependent on the chosen aggregation method. If the TRI is assumed to be the most exact aggregation measure, welfare effects are most likely underestimated with trade weighted tariffs. Given these results, it might no longer be true that the measurable costs of protection are not large in percentage terms of the GDP as Krugmann (1995) describes in what he called a "dirty little secret". A consideration might be especially worthwhile when NTB's are additionally taken into account.

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