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Aggregation of Tariff-Rate Quotas within GTAP Sectors

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Abstract

Aziz Elbehri and Ken Pearson supplied an approach to implement tariff-rate quotas in the general equilibrium model of the Global Trade Analysis Project (GTAP). For each traded good a tariff-rate quota can be introduced whereby good refers to a sector of the GTAP data base. If a sector contains several tariff lines, which may have their own tariff-rate quota regimes, an aggregation is needed leading to a sector-wide tariff-rate quota. In the paper two alternative aggregation methods are suggested considering either magnitude of tariffs or sector-wide quota rent. In an example both aggregation methods are applied to show the impact on model results.

Key words: tariff-rate quota, GTAP model, GTAP data base, aggregation

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This paper contains the suggestions that the authors made to Elbehri and Pearson. They can be found in their technical paper (Elbehri and Pearson) on pages 43 to 45.

1 Introduction

An important outcome of the Uruguay Round was the implementation of tariff-rate quotas (TRQ) as a new policy instrument. Applied on a tariff line level (6- or 8-digit) a fixed quantity (quota) can be imported at a relatively low in-quota tariff and guarantees a minimal market access. Imports above that quantity are charged with a relatively high over-quota tariff.

Elbehri and Pearson supplied a modification of the general equilibrium model of the Global Trade Analysis Project (GTAP, Hertel and Tsigas) to implement TRQs. An extensive description of the approach can be found in their technical paper (Elbehri and Pearson, chapter 3). The approach allows the introduction of a TRQ for each trade relation; i.e. for a good i transported from region r to region s, whereby good i refers to a sector of the GTAP data base. This offers the possibility to analyze TRQs in a general equilibrium model if a GTAP sector refers exactly to a tariff line. For instance this is the case with sugar (Elbehri, Hertel, Ingco et al.). Like other data bases of general equilibrium models, most of the GTAP sectors consist of several tariff lines. In these cases the analysis of a single TRQ can not be carried out with the GTAP model; a satellite model is required (Francois, p. 58). In view of analyzing global economic issues we would like to focus on another aspect: The work of Elbehri and Pearson enables GTAP users to include TRQs explicitly as policy instruments on a sector level like tariffs or subsidies. This seems to be relevant because market access is an important subject at the ongoing WTO negotiation round and furthermore TRQs are a widely used instrument: 37 WTO member countries have a combined total of 4’993 tariff lines with a TRQ (Abbott, p. 118). Considering the prevalence of TRQs in livestock products trade barriers, model results can be biased when TRQs are neglected (Rae, p. 16). This is especially true if a tariff reduction or an enlargement of TRQs is analyzed. Conversely, introducing TRQs requires a noticeable effort. So it is up to the model user to decide if the introduction of a TRQ is appropriate.

Before the approach by Elbehri and Pearson can be applied, all tariff lines within a GTAP sector have to be aggregated, so that a sector-wide TRQ results. This is a challenge since each tariff line may have its own TRQ. The question arises as to how to aggregate them. In this paper we suggest two different aggregation methods, considering either the magnitude of tariffs or the sector-wide quota rent. Both aggregation methods allow the depiction of TRQs even if a GTAP sector comprises several tariff lines with their own TRQ regime.

The organisation of the paper is as follows. In the next section we look at the necessary additional coefficients for implementing TRQs in the GTAP model. In section three both

aggregation methods are presented. Section four contains an illustrative example. The last section deals with some conclusions.

2 Necessary coefficients

The GTAP data base includes for every good i transported from region r to region s the value at the cif-price level ($VIWS_{i,r,s}$) and the tariff of import region s ($MTAX_{i,r,s}$). In figure 1a both values and the demand function for imports of region s are depicted. For convenience the indices (i,r,s) are neglected. Although the imported quantity is denoted as QXS in figure 1a, the GTAP data base only includes values. In the same way the cif-price (PCIF) and the price after adding the tariff (PMS) just serve as illustration. To implement TRQs the approach by Elbehri and Pearson requires three additional coefficients for every trade relation, which refer to the same year as the data base (Elbehri and Pearson p.13). The first of them (QXSTRQ_RATIO) shows the relation between the imported quantity and the quota quantity:

$$QXSTRQ\_RATIO = \frac{QXS}{Quota\ Quantity}$$

Two further coefficients depict the tariffs: TMSINQ is the in-quota tariff. TMSTRQOVQ is the extra power of the tariff levied on over-quota imports. With regard to a graphical depiction, the three coefficients enable us to separate the import tax MTAX into three areas: the quota rent, the in-quota and the over-quota tariff revenues (figure 1b). The introduced tariffs must fulfil the following equation:

PMS = PCIF * TMSINQ * TMSTRQOVQ

If a GTAP sector consists of only one tariff line, all three coefficients can be found in the trade statistics and the tariff list. If a sector consists of several tariff lines, the coefficients are the result of an aggregation process. Since the necessary information of the tariffs may stem from other data sources than the GTAP data base does, the fulfilment of the equation above is unlikely. Therefore an adjustment process is necessary. This is carried out preliminary to the model simulation (first step of the procedure suggested by Elbehri and Pearson, chapter 3.3.1). The coefficients TMSINQ and TMSTRQOVQ are generated from the coefficients IQT and OQT which come from a tariff list or an aggregation process. IQT is the temporary form

of TMSINQ and OQT that of TMSTRQOVQ. While the absolute values of IQT and OQT are negligible, only the relation between them is important.

3 Aggregation methods for quantities and tariffs

It is possible that a trade relation resp. a sector of the GTAP data base consists of several tariff lines. For example, the sector meat of ruminants (19/ CMT) includes meat products of cattle, sheep, goats and horses. Every tariff line may have its own TRQ. The situation of the several tariff lines may differ: in some cases, imported quantity may exceed the quota quantity and consequently the over-quota tariff is used, while other tariff lines are below their quota quantity and the in-quota tariff is applicable. For the aggregation of the TRQs within a GTAP sector, we look first at the aggregation of quantities and afterwards at the aggregation of tariffs[2]. For both aggregations we assume that all TRQs within a GTAP sector are completely independent of each other.

If at least one tariff line exceeds its quota quantity, we assume that the sector-wide TRQ also exceeds the aggregated quota quantity. The import of this one tariff line yields a quota rent, and consequently the aggregated or sector-wide quota rent is greater than zero. This also means that the aggregated import quantity must attain or exceed the aggregated quota quantity. Otherwise there would be no quota rent. Consequently the coefficient QXSTRQ_RATIO is at least equal to 1. QXSTRQ_RATIO can also be calculated (appendix B). Therefore the imported quantities under in-quota tariff as well as over-quota tariff are needed for every tariff line. The sector-wide imported quantity results from the addition of both quantities of all tariff lines within a GTAP sector. We divide it by the sum of in-quota quantities of all tariff lines within the GTAP sector. Please note that it is possible that the calculation of QXSTRQ_RATIO yields a value below 1 even if at least one tariff line reaches its quota quantity. In this case we suggest choosing a value slightly greater than 1 for QXSTRQ_RATIO. It may be that a sector comprises tariff lines with, as well as without, TRQ regime. One possibility to handle it is to treat tariff lines without TRQ regime in the same way as tariff lines with TRQ regime whereby the quota quantity is not attained.

[2] The approach by Elbehri and Pearson allows the introduction of a TRQ for every trade relation. So the aggregation has to be made for every region of origin. To facilitate the explanations it can be assumed that only one region of origin is considered. Therefore in section three we renounce to mention that the aggregation has to be made for every region of origin.

For the aggregation of tariffs we need the in- and over-quota tariffs for each tariff line. The obvious way to aggregate them would be to take the simple average. But a weighted average based on import volume or imported weights seems to be more appropriate. This is the first suggested aggregation method. The manner of calculation is presented in appendix C. After calculation of the aggregated cif-price as well as in- and over-quota tariffs the two coefficients IQT and OQT are derived. While this aggregation method reflects the real magnitude of the aggregated in- and over-quota tariffs quite clearly, its weakness is illustrated by an example: Assume that a GTAP sector comprises two tariff lines. By each of them the TRQ regime is applied. We assume further that the first tariff line exceeds slightly the quota quantity, while the second tariff line almost reaches its quota quantity. Finally we suppose that in- and over-quota tariffs as well as quota quantities are identical. If we apply the first suggested aggregation method, aggregated tariffs are equal to those of the two tariff lines. Since the first tariff line exceeds its quota quantity this is also true for the sector-wide TRQ. The resulting sector-wide quota rent is approximately twice the quota rent of the first tariff line because almost twice the quantity of the first tariff line is imported. That is not correct, because the aggregated quota rent is identical with the quota rent of the first tariff line. The second tariff line has no quota rent. So we have to conclude that the aggregation method considering tariffs leads to an inexact aggregated quota rent. Therefore we suggest a second aggregation method, which considers the sector-wide quota rent. Appendix D contains the calculation. Since the aggregated in-quota tariff is independent on the aggregated quota rent, the same manner of calculation is used as for the aggregation method considering tariffs. The difference lays in the calculation of the aggregated over-quota tariff. Therefore we have to add the quota rents and the over-quota tariff revenues of all tariff lines. Afterwards we divide it by the sector-wide imported quantity. The second aggregation method offers an accurate sector-wide quota rent, but distortions must be accepted with regard to tariff magnitudes. Unfortunately it is not possible to achieve both accurate quota rent and accurate magnitude of tariffs when TRQs are aggregated. Returning to our example with two tariff lines, the two aggregation methods are depicted in figure 2. The left-hand side shows the aggregation method considering tariffs whose aggregated quota rent is obviously larger than on the right. For the latter the aggregation method considering quota rent was applied. Generally speaking, if at least one tariff line does not attain the quota quantity, the aggregation method considering tariffs leads to a lower in-quota tariff, since the sector-wide quota rent is overestimated. Only if all tariff lines exceed their quota quantities both aggregation methods lead to the same result.

4 An illustrative example

As an illustration we simulate the unilateral duplication of two Swiss TRQs. The experiment is calculated twice using either aggregation method. Therefore we use the GTAP 5 data base (Dimaranan and McDougall) and aggregate it to three regions (Switzerland, European Union and rest of the world) and 18 sectors. The sectors are wheat, other grains, vegetables and fruit, oilseeds, sugar beet, other crops, cattle and sheep, pork and poultry, raw milk production, meat of ruminants, other meat, oils and fats, dairy products, sugar, beverages and tobacco, other foods, industry and services. The production of sugar beet and raw milk is limited by a quota in Switzerland. Therefore output quotas are introduced into the GTAP model (Lips and Rieder). We introduce the TRQ regime for two Swiss sectors: meat of ruminants, and other meat. The corresponding trade relations between Switzerland and the European Union on the one hand and the rest of the world on the other hand are treated in the same way. Both meat sectors consist of 16 or more tariff lines. The TRQ regime is applied to all of them. At least three of the tariff lines attain their quota quantities. Consequently, the aggregated sector-wide TRQs exceed their quota quantities.

Looking at the results we concentrate on the changes of produced quantities (table 1) and prices (table 2) of the Swiss sectors. All results are presented in percentage changes and refer to the year of the data base (1997).

Due to the duplication of the TRQs the imports of both meat sectors do no longer reach their quota quantity. The quota rents drop out. Consequently imports are cheaper and partly replace the domestic products. Since not all tariff lines attain their quota quantities in the initial situation, the aggregation method considering tariffs leads to lower in-quota tariffs than the aggregation method considering quota rents (figure 2). Hence the price reduction of imports is higher using the aggregation method considering tariffs. Consequently the impact on produced quantities is stronger with this aggregation method. For instance the quantity other meat decreases by 4.1 % if tariffs are considered (table 1). Applying the aggregation method considering quota rent the reduction is only 1.4 %. Similar differences can be observed by the sectors meat of ruminants, cattle and sheep, pork and poultry as well as other grains, which is an important input for meat production.

If we look at the sectors with a output quota (sugar beet and raw milk production) both aggregation methods show no change in terms of quantities. Due to the quota a decrease in demand results in a price reduction, which is larger with the aggregation method considering tariffs (table 2).

5 Conclusions

If a sector of the GTAP data base includes several tariff lines with their own TRQs, the question arises as to how to aggregate them to a sector-wide TRQ, so that the approach by Elbehri and Pearson can be applied. In this paper two methods are suggested, either considering magnitude of tariffs or sector-wide quota rent. If at least one tariff line does not attain their quota quantity, the aggregation method considering tariffs leads to a lower in-quota tariff. Comparing both aggregation methods, differences can be stated in model results as the previous section shows. Due to the fact that it is impossible to take into consideration both magnitude of tariffs and sector-wide quota rent, we suggest calculating the model twice using either aggregation method. The lack of a compelling argument in favour of one specific approach supports that. Using both methods can be regarded as a kind of sensitivity analysis of the aggregation process.

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Appendix A: Necessary Data

In the appendixes the formal calculations of the three necessary coefficients $QXSTRQ\_RATIO_{i,r,s}$, $IQT_{i,r,s}$ and $OQT_{i,r,s}$ are presented. For the sake of completeness all indices are noted. It has to be mentioned that in Switzerland tariffs are imposed on weight instead of ad valorem, as is the case in most countries. Consequently prices and tariffs refer to a fixed quantity[3]. In table 3 all required coefficients from the foreign trade statistics (Eidgenössische Oberzolldirektion 1998) and the list of tariffs (Eidgenössische Oberzoll-direktion 1997) are included. Although these coefficients are not in the GTAP data base, their names rely on the GTAP notification. We hope that this is a facilitation.

Appendix B: Coefficient QXSTRQ_RATIO

We can aggregate the in- and over-quota quantity to the total imported quantity of tariff line k of sector i transported from region r to region s:

$$QXS_{k,i,r,s} = QXS_{k,i,r,s,in-quota} + QXS_{k,i,r,s,over-quota}$$

The coefficient $QXSTRQ\_RATIO_{i,r,s}$ is defined as:

$$QXSTRQ\_RATIO_{i,r,s} = \frac{\sum_{k} QXS_{k,i,r,s}}{\sum_{k} QXS_{k,i,r,s,in-quota}}$$

Appendix C: Aggregation method considering tariffs

Before calculating $IQT_{i,r,s}$ and $OQT_{i,r,s}$ we need the sector-wide cif-price ($PCIF_{i,r,s}$) as well as the aggregated in- and over-quota tariffs. For the cif-price of good i transported from region r to region s the values of all tariff lines are divided by the imported quantity:

[3] They are defined per 100 kg.

$$PCIF_{i,r,s} = \frac{\sum_{k} VIWS_{k,i,r,s}}{\sum_{k} QXS_{k,i,r,s}}$$

Aggregated in- and over-quota tariffs are the weighted average of the tariffs of all tariff lines:

$$IN-QUOTA-TARIFF_{i,r,s} = \sum_{k}\left[\frac{QXS_{k,i,r,s}}{\sum_{k} QXS_{k,i,r,s}}\left(IN-QUOTA-TARIFF_{k,i,r,s}\right)\right]$$

$$OVER-QUOTA-TARIFF_{i,r,s} = \sum_{k}\left[\frac{QXS_{k,i,r,s}}{\sum_{k} QXS_{k,i,r,s}}\left(OVER-QUOTA-TARIFF_{k,i,r,s}\right)\right]$$

We can now calculate the two coefficients $IQT_{i,r,s}$ and $OQT_{i,r,s}$:

$$IQT_{i,r,s} = \frac{PCIF_{i,r,s} + \left(IN-QUOTA-TARIFF_{i,r,s}\right)}{PCIF_{i,r,s}}$$

$$OQT_{i,r,s} = \frac{PCIF_{i,r,s} + \left(OVER-QUOTA-TARIFF_{i,r,s}\right)}{PCIF_{i,r,s} + \left(IN-QUOTA-TARIFF_{i,r,s}\right)}$$

Appendix D: Aggregation method considering quota rent

While the manner of calculation is identical for the aggregated cif-price and the in-quota tariff, the sector-wide over-quota tariff is calculated differently[4]. We form the coefficient $A_{i,r,s}$ which contains the quota rents and the over-quota tariff revenues of all tariff lines of sector resp. good i transported from region r to region s:

$$A_{i,r,s} = \sum_{k}\left(\left[\left(OVER-QUOTA-TARIFF_{k,i,r,s}\right)-\left(IN-QUOTA-TARIFF_{k,i,r,s}\right)\right] * QXS_{k,i,r,s} * QT_{k,i,r,s}\right)$$

A case differentiation must be made: Only the additional income of those TRQs, which exceed their quota quantity, should be added. Consequently $QXS_{k,i,r,s,over\text{-}quota}$ has to be greater than 0. The coefficient $QT_{k,i,r,s}$ depends on that question:

$QXS_{k,i,r,s,over\text{-}quota} > 0 \rightarrow QT_{k,i,r,s} = 1$

$QXS_{k,i,r,s,over\text{-}quota} = 0 \rightarrow QT_{k,i,r,s} = 0$

[4] The coefficient $IQT_{i,r,s}$ is identical with the aggregation method considering tariffs. That does not matter, since the relation of $IQT_{i,r,s}$ and $OQT_{i,r,s}$ and not the absolute values are important in the adjustment process preliminary to the model simulation (Elbehri and Pearson, chapter 3.3.1).

If a tariff line reaches exactly its quota quantity, ($QXS_{k,i,r,s,in\text{-}quota}$ = quota quantity) it is assumed that the over-quota tariff is used, since an estimation of the quota rent is difficult and time -consuming. The aggregated over-quota tariff is now:

$$OVER-QUOTA-TARIFF_{i,r,s} = IN-QUOTA-TARIFF_{i,r,s} + \frac{A_{i,r,s}}{\sum_{k} QXS_{k,i,r,s}}$$

The coefficients $IQT_{i,r,s}$ and $OQT_{i,r,s}$ are derived in the same way as in appendix C.

Figure 1: Imports in the GTAP data base and introduction of a TRQ

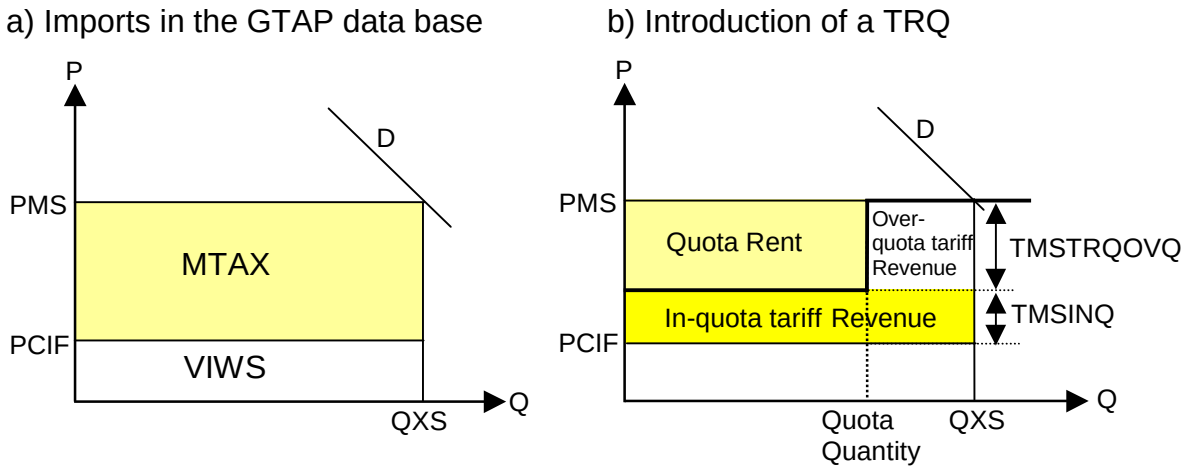

Figure 2: Two aggregation methods

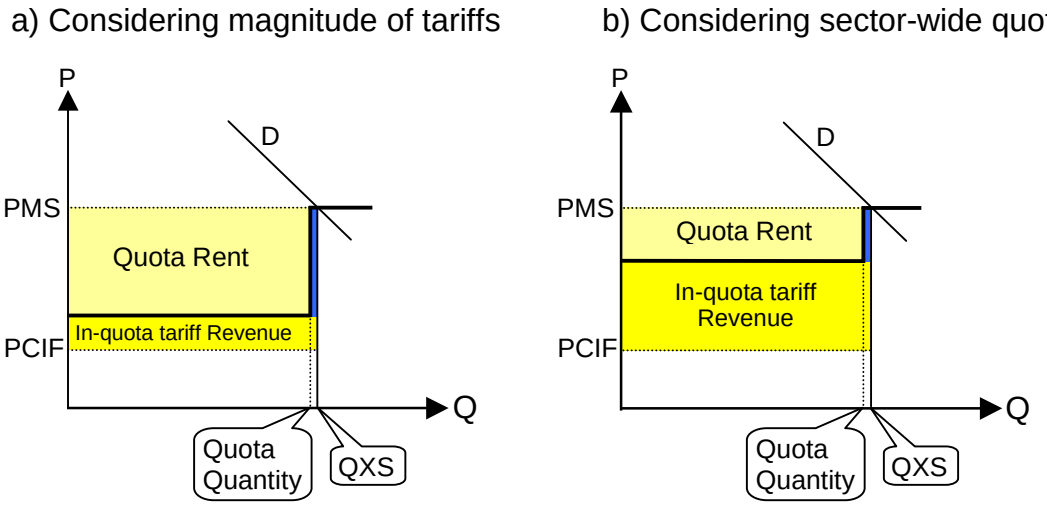

Table 1: Changes of produced quantities in Switzerland in %

aggregation method	considering tariffs	considering quota rent
wheat	-0.1	0.0
other grains	-1.6	-0.8
vegetables and fruit	0.1	0.0
oilseeds	0.1	0.1
sugar beet	0	0
other crops	-0.1	-0.1
cattle and sheep	-2.8	-2.0
pork and poultry	-3.2	-1.6
raw milk production	0	0
meat of ruminants	-3.6	-2.6
other meat	-4.1	-1.4
oils and fats	-0.2	0.0
dairy products	0.4	0.3
sugar	0.1	0.1
beverages and tobacco	0.1	0.0
other foods	0.0	0.0
industry	0.1	0.0
services	0.0	0.0

Table 2: Changes of producer prices in Switzerland in %

aggregation method	considering tariffs	considering quota rent
wheat	-0.3	-0.1
other grains	-0.4	-0.2
vegetables and fruit	-0.1	0.0
oilseeds	-0.3	-0.2
sugar beet	-1.0	-0.4
other crops	0.0	0.0
cattle and sheep	-0.5	-0.3
pork and poultry	-0.3	-0.2
raw milk production	-1.2	-0.9
meat of ruminants	-0.7	-0.5
other meat	-2.3	-1.4
oils and fats	-0.3	-0.2
dairy products	-0.6	-0.4
sugar	-0.5	-0.2
beverages and tobacco	0.0	0.0
other foods	-0.2	-0.1
industry	0.0	0.0
services	0.0	0.0

Table 3 : Necessary additional coefficients

Abbreviation	Explanation
$VIWS_{k,i,r,s}$	value of tariff line k of good resp. sector i transported from region r to region s
$QXS_{k,i,r,s,in\text{-}quota}$	quantity of tariff line k of good resp. sector i transported from region r to region s, imported at in-quota tariff
$QXS_{k,i,r,s,over\text{-}quota}$	quantity of tariff line k of good resp. sector i transported from region r to region s, imported at over-quota tariff
$IN\text{-}QUOTA\text{-}TARIFF_{k,i,r,s}$	in-quota tariff of tariff line k of good resp. sector i transported from region r to region s
$OVER\text{-}QUOTA\text{-}TARIFF_{k,i,r,s}$	over-quota tariff of tariff line k of good resp. sector i transported from region r to region s
$QT_{k,i,r,s}$	binary coefficient; equal to 1 if the tariff line k of good resp. sector i transported from region r to region s exceeds quota quantity, otherwise equal to 0