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A User Guide for the Excel Interface to Compute Optimal Tariff Aggregators

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1 Introduction

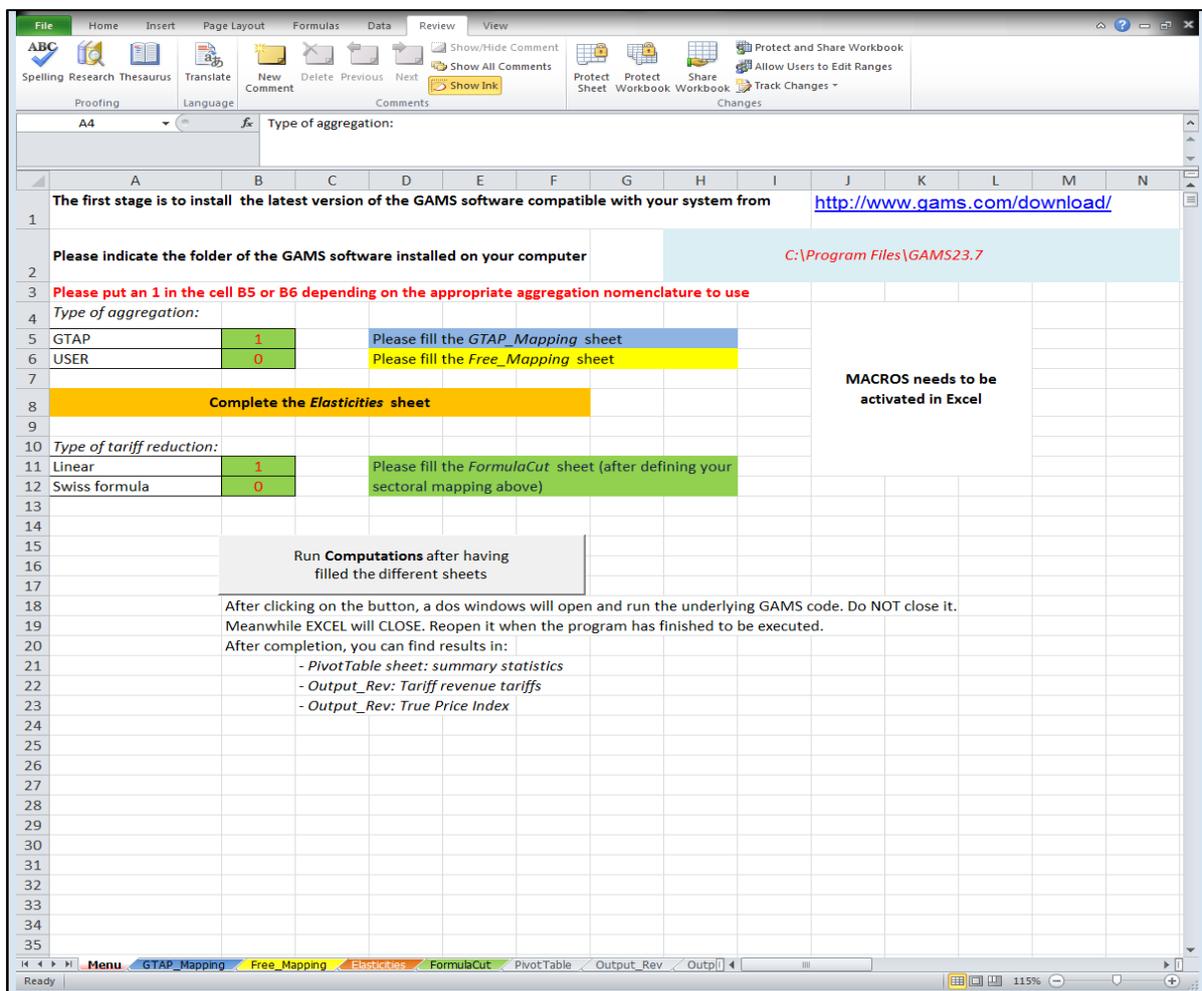
This tool has been developed in order to compute alternative aggregated tariffs, based on users' choices of regions and commodities.

The following sections explain how the Excel file "Aggregator_menu.xlsm" should be used.

The mathematical expressions included in the GAMS file running the aggregator in the background of the Excel workbook are presented in the [mathematical appendix](#) of this documentation. The data used, and instructions about how to update them are presented in the [dataset appendix](#).

Let's focus now on the workbook. When opening the Excel file, the following window appears:

Figure 1. Main menu



2 Step 1: Install the latest version of GAMS

The aggregator tool was developed based on GAMS version 23.7. If this software is not installed, users should follow the instruction from www.gams.com/download and make sure that the software is installed in the directory: C:\Program Files\GAMS23.7.

3 Step2: Aggregation mapping

The user can either chose to define aggregate commodities and regions based on the GTAP categories, or on the HS6 and ISO nomenclature. If the user wishes to use a mapping based on GTAP, then he/she should put a value of 1 in cell B5 and 0 in cell B6 and fill the “GTAP_Mapping” spreadsheet to establish the correspondence between the GTAP commodities and the user code.

Figure 2. GTAP7 Mapping

3	Please put an 1 in the cell B5 or B6 depending on the appropriate aggregation nomenclature to use						
4	Type of aggregation:						
5	GTAP	1		Please fill the <i>GTAP_Mapping</i> sheet			
6	USER	0		Please fill the <i>Free_Mapping</i> sheet			
7							

Conversely, if the user wishes to establish a mapping based on the HS6 nomenclature and on ISO codes, then he/she should put a value of 0 in cell B5 and 1 in cell B6 and fill the “Free_mapping” spreadsheet according to their own codes.

Figure 3. Free Mapping

3	Please put an 1 in the cell B5 or B6 depending on the appropriate aggregation nomenclature to use						
4	Type of aggregation:						
5	GTAP	0		Please fill the <i>GTAP_Mapping</i> sheet			
6	USER	1		Please fill the <i>Free_Mapping</i> sheet			
7							

4 Step 3: Assign values to elasticities

Once the mapping has been defined, the user should assign values to the different elasticities used to compute the weighted tariffs¹. This is done in the spreadsheet “Elasticities”, shown below. Note that column A is filled automatically from the user code defined in step 2.

¹ See the mathematical appendix

Figure 4. Elasticities

	A	B	C	D	E	F	G	H	I	J	K
1		SIGMA1	SIGMA2	SIGMA3			SIGMA1: across importers				
2	ric	1.1	2	10			SIGMA2: across products				
3	gro	1.1	2	10			SIGMA3: across exporters (Armington elasticity)				
4	v_f	1.1	2	10							
5	osd	1.1	2	10							
6	sug	1.1	2	10							
7	pfb	1.1	2	10							
8	ocr	1.1	2	10							
9	lvs	1.1	2	10							
10	onr	1.1	2	10							
11	ofd	1.1	2	10							
12	ffl	1.1	2	10							

5 Step 4: Define the tariff reductions

The baseline tariffs are automatically computed and will be displayed along with items from any tariff changes being simulated. The user must first determine whether the reduction he/she will enter are expressed in a linear manner or following the Swiss formula.

To select the linear way, the user must put 1 in cell B11 and 0 in cell B12.

Figure 5. Linear tariff reduction

10	Type of tariff reduction:										
11	Linear	1				Please fill the <i>FormulaCut</i> sheet (after defining your sectoral mapping above)					
12	Swiss formula	0									

Conversely, if the user prefers simulating tariff reductions implemented through the Swiss formula, he/she should put 0 in cell B11 and 1 in cell B12.

Figure 6. Swiss formula

10	Type of tariff reduction:										
11	Linear	0				Please fill the <i>FormulaCut</i> sheet (after defining your sectoral mapping above)					
12	Swiss formula	1									

Once this is done, the user must then fill the spreadsheet “FormulaCut”. Note that the first column will automatically be filled with the user’s code (see step 2).

Figure 7. Tariff reduction

	A	B	C	D	E	F	G	H	I	J
1		Coefficient Value		<i>Coefficient value: indicate percentage of reduction (as 0.5 for 50%) or swiss</i>						
2	ric	0.5								
3	gro	1								
4	v_f	1								
5	osd	1								
6	sug	1								
7	pfb	1								
8	ocr	1								
9	lvs	1								
10	onr	1								
11	ofd	1								
12	ffl	1								

The linear method implies that the coefficient value (CV) introduced in column B indicates the percentage of reduction and will impact the tariffs the following way:

$$tariff_i^1 = tariff_i^0 \times (1 - CV_i) \quad (1)$$

For example, to introduce a 50% tariff cut, one should put a value of 0.5 in the spreadsheet “FormulaCut”. Similarly, complete elimination of tariffs corresponds to $CV_i=1$ for all commodities.

Whereas the Swiss method implies that the coefficient value will impact the tariffs this way:

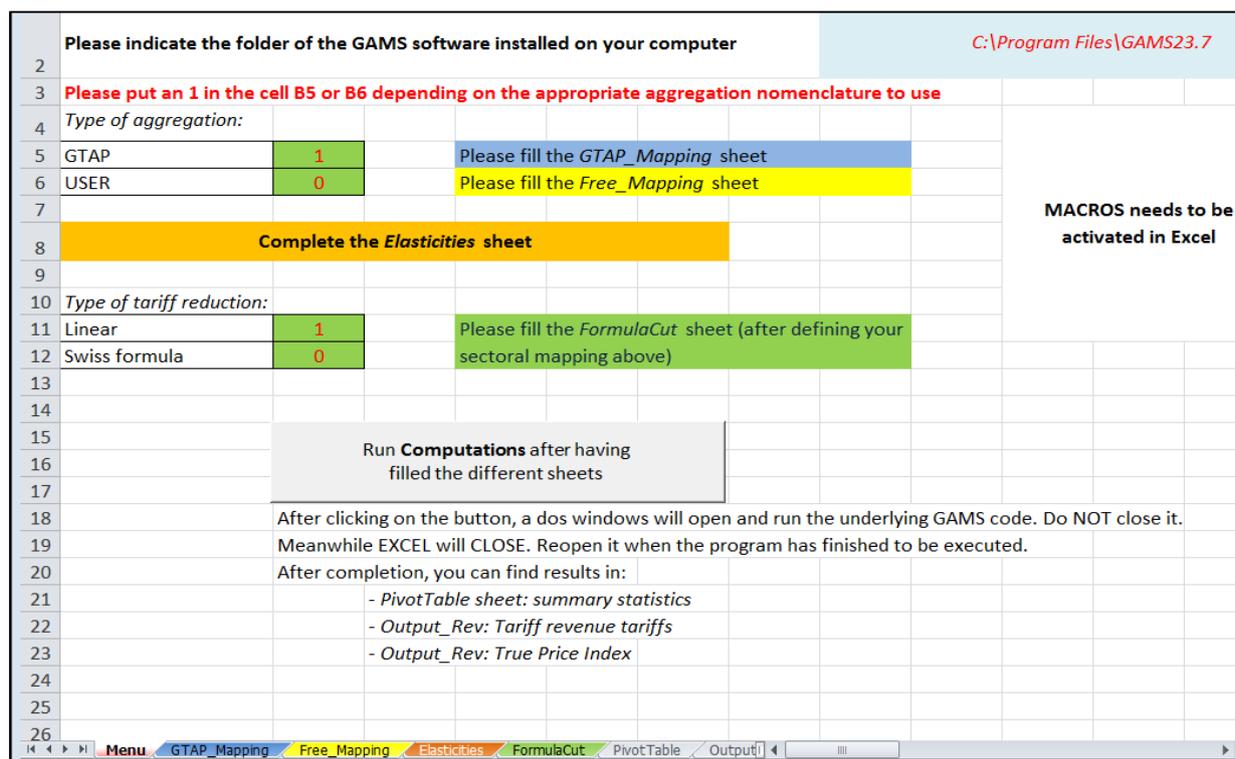
$$tariff_i^1 = \frac{tariff_i^0 \times SF_i}{tariff_i^0 + SF_i} \quad (2)$$

For example, a Swiss formula coefficient of 5 should be entered as 0.05 in the spreadsheet “FormulaCut”

6 Step 5: Compute the new weighted tariffs

Once all of these steps have been completed, the user must go back to the first spreadsheet (“Menu”) and click on the gray rectangular “Run Computations...”.

Figure 8. Computation



Doing so will automatically close Excel and a DOS window will appear and use GAMS to compute the new weighted tariffs. Be patient, this step may take some time...

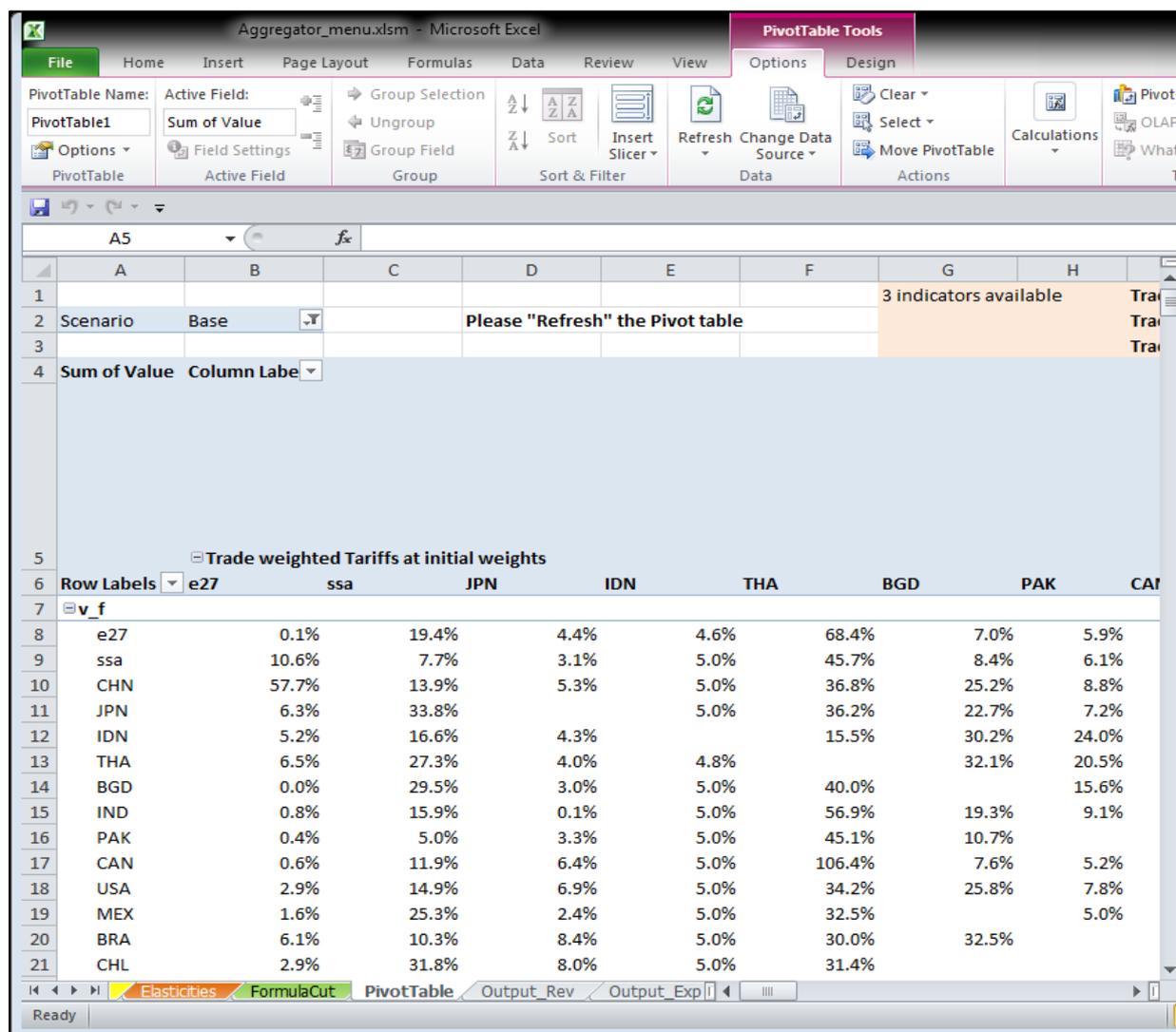
7 Step 6: See the results

Once GAMS has completed its calculations, the DOS window will automatically close. The user should then reopen the Excel workbook "Aggregator_menu.xlsm". The results will appear in the three last spreadsheets of the workbook.

The "PivotTable spreadsheet" presents the different aggregators discussed below in a summary table. The data in this table is taken from the following spreadsheets, in which output from GAMS is presented in a manner more convenient for its use in further modelling.

Do not forget to refresh this table when reopening the Excel file in order to update the information it contains. This can be done by clicking on the Refresh button in the Pivot Table Tools, under the Options tag, as shown in the figure above.

Figure 9. Pivot Table



In this worksheet, empty cells indicate the absence of trade flows for this bilateral trade relation.

Two other sheets present output that can be easily exported to feed a model.

- **Output_rev**: A four dimension output that displays the value (column E) of the sectoral bilateral tariff as defined by the **Tariff Revenue Aggregator (TRA)** for the *scenario* (Base = initial tariff, simu= post tariff cut), the *sector* code (code), the exporting region code (*Exporter*) and the importing region code (*Importer*).
- **Output_exp**: A four dimension output that displays the value (column E) of the sectoral bilateral **Expenditure Aggregator (EXA)**. The dimensions the *scenario* (Base = initial tariff, simu= post tariff cut), the *sector* code (code), the exporting region code (*Exporter*) and the importing region code (*Importer*).

In a CGE-type model, the inputs will be used in the following way:

$$PDOM(i, r, s) = CIFP(i, r, s) * (1 + TRA(i, r, s)) \quad (3)$$

This equation is the “traditional” price equation showing the border protection effect.

$$PDOMU(i, r, s) = CIFP(i, r, s) * (1 + EXA(i, r, s)) \quad (4)$$

This equation shows how the aggregation procedure will correct the utility price of the imported quantity.

$$PDOM(i, r, s) * IMP(i, r, s) = PDOMU(i, r, s) * IMPU(i, r, s) \quad (5)$$

This equation ensures that despite the change of unit, the value spent on the import bill, at domestic prices, remain the same.

With i the sectoral index, r the exporting region index, s the importing region index, CIFP the CIF price by traded unit (i.e. aggregated a world price), PDOM the domestic price by traded unit (i.e. aggregated a world price), and PDOMU the domestic price of imported quantity in domestic quantity.

It is easy to show that (c) can be rewritten as:

$$IMPU(i, r, s) = \frac{PDOM(i, r, s)}{PDOMU(i, r, s)} * IMP(i, r, s) \quad (6)$$

$$IMPU(i, r, s) = \frac{(1+TRA(i, r, s))}{(1+EXA(i, r, s))} * IMP(i, r, s) \quad (7)$$

The last equation being equivalent to Eq.9 in Laborde et al. (2011).

8 Mathematical appendix

Trade data have at least three dimensions: commodity, exporter, and importer. The raw data are frequently very disaggregated in each dimension. The database consists of trade, $trade_{hs6,m,n}$ and tariffs, $t_{hs6,m,n}$. Define $pcif_{hs6,m,n}$ as the CIF price and $pd_{hs6,m,n}$ as the domestic price, or the price paid by the importer inclusive of tariffs. Then:

$$pd_{hs6,m,n} = pcif_{hs6,m,n} (1 + t_{hs6,m,n}) \quad (1)$$

In most models, however, the variables used must be more highly aggregated. Therefore, even though the quantities, prices and tariffs also three dimensions, the commodities and trading partners are in most cases aggregates of the sets used in the raw data. Assume that r and s both refer to the same set of partners, which corresponds to some aggregation of set m . Assume further that set i is an aggregate of HS6 commodities. Then $TRADE_{i,r,s}$ defines the volume of commodity i imported by s from r , $PCIF_{i,r,s}$ the CIF price, $PD_{i,r,s}$ the domestic price, and $T_{i,r,s}$ the tariffs. Hence:

$$PD_{i,r,s} = PCIF_{i,r,s} (1 + T_{i,r,s}) \quad (2)$$

Since commodities and trading partners are aggregates of larger sets described earlier, and given that we have data on both trade ($trade_{hs6,m,n}$) and (tariffs, $t_{hs6,m,n}$), the tariffs that apply to the aggregated trade must reflect this information.

8.1 Trade weighted tariffs at initial (constant) weights

The most commonly used aggregator for tariffs is the weighted-average tariff, using initial value shares. In other words:

$$T_{i,r,s} = T WO_{i,r,s} = \frac{\sum_{hs6 \in i, m \in r, n \in s} trade_{hs6,m,n}^0 \cdot t_{hs6,m,n}}{\sum_{hs6 \in i, m \in r, n \in s} trade_{hs6,m,n}^0} \quad (3)$$

Where the superscript 0 refers to the initial period. The initial aggregator in this case is defined as:

$$T_{i,r,s}^0 = T WO_{i,r,s}^0 = \frac{\sum_{hs6 \in i, m \in r, n \in s} trade_{hs6,m,n}^0 \cdot t_{hs6,m,n}^0}{\sum_{hs6 \in i, m \in r, n \in s} trade_{hs6,m,n}^0} \quad (4)$$

And any changes in tariffs are taken into account using these initial weights:

$$T_{i,r,s}^1 = T WO_{i,r,s}^1 = \frac{\sum_{hs6 \in i, m \in r, n \in s} trade_{hs6,m,n}^0 \cdot t_{hs6,m,n}^1}{\sum_{hs6 \in i, m \in r, n \in s} trade_{hs6,m,n}^0} \quad (5)$$

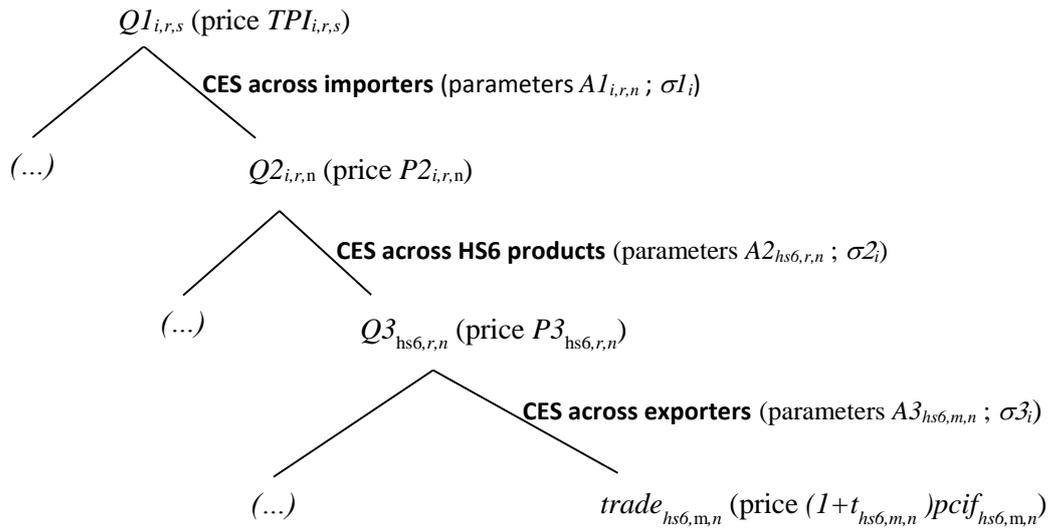
These vectors are consistent with Leontief preferences between HS6 commodities and between the goods supplied by different trading partners. These measures appear as the first indicator in the Excel spreadsheet “PivotTable”.

8.2 Trade weighted tariffs at final weights

Most models assume some substitution possibilities between commodities and trading partners, with the Armington assumption being probably the most widely used. If this specification is to be used, then, one knows that a change in tariff would imply some substitution between commodities and/or trading partners. The aggregator based on initial shares is clearly not consistent with this specification:

$$T_{i,r,s}^1 = TW1_{i,r,s}^1 = \frac{\sum_{hs6 \in i, m \in r, n \in s} trade_{hs6,m,n}^1 \cdot t_{hs6,m,n}^1}{\sum_{hs6 \in i, m \in r, n \in s} trade_{hs6,m,n}^1} \quad (6)$$

Let us define the following nested CES specification:



In mathematical terms:

$$Q1_{i,r,s} = \left\{ \sum_{n \in s} A1_{i,r,n}^{1/\sigma1_i} \cdot Q2_{i,r,n}^{(\sigma1_i-1)/\sigma1_i} \right\}^{\sigma1_i/(\sigma1_i-1)} \quad (7)$$

$$Q2_{i,r,n} = \left\{ \sum_{hs6 \in i} A2_{hs6,r,n}^{1/\sigma2_i} \cdot Q3_{hs6,r,n}^{(\sigma2_i-1)/\sigma2_i} \right\}^{\sigma2_i/(\sigma2_i-1)} \quad (8)$$

$$Q3_{hs6,r,n} = \left\{ \sum_{m \in r} A3_{hs6,m,n}^{1/\sigma_{3i}} \cdot trade_{hs6,m,n}^{(\sigma_{3i}-1)/\sigma_{3i}} \right\}^{\sigma_{3i}/(\sigma_{3i}-1)} \quad (9)$$

With the corresponding exact prices:

$$TPI_{i,r,s} = \left\{ \sum_{n \in s} A1_{i,r,n} \cdot P2_{i,r,n}^{(1-\sigma_{1i})} \right\}^{1/(1-\sigma_{1i})} \quad (10)$$

$$P2_{i,r,n} = \left\{ \sum_{hs6 \in i} A2_{hs6,r,n} \cdot P3_{hs6,r,n}^{(1-\sigma_{2i})} \right\}^{1/(1-\sigma_{2i})} \quad (11)$$

$$P3_{hs6,r,n} = \left\{ \sum_{m \in r} A3_{hs6,m,n} \cdot [(1+t_{hs6,m,n}) \cdot pcif_{hs6,m,n}]^{(1-\sigma_{3i})} \right\}^{1/(1-\sigma_{3i})} \quad (12)$$

And the demand functions :

$$Q2_{i,r,n} = A1_{i,r,n} \cdot Q1_{i,r,s} \cdot \left[\frac{TPI_{i,r,s}}{P2_{i,r,n}} \right]^{\sigma_{1i}} \quad (13)$$

$$Q3_{hs6,r,n} = A2_{hs6,r,n} \cdot Q2_{i,r,n} \cdot \left[\frac{P2_{i,r,n}}{P3_{hs6,r,n}} \right]^{\sigma_{2i}} \quad (14)$$

$$trade_{hs6,m,n} = A3_{hs6,m,n} \cdot Q3_{hs6,r,n} \cdot \left[\frac{P3_{hs6,r,n}}{pcif_{hs6,m,n} \cdot (1+t_{hs6,m,n})} \right]^{\sigma_{2i}} \quad (15)$$

A change in tariffs would thus primarily impact price $P3$ (through equation 12), which would in turn impact $P2$ (equation 11) and ultimately price TPI (equation 10). Each new price will translate into new demands (equations 13 to 15), and thus we can calculate the trade weighted tariffs at final share (equation 6). This value is the second indicator reported in the Excel spreadsheet “PivotTable”.

8.3 Trade weighted Tariffs – Expenditure

Assuming the same nested structure, an approach based on the expenditure function is appropriate when seeking estimates of substitution effects in demand, or the terms-of-trade.

Define $TPI_{i,r,s}^0$, as the aggregated price based on initial tariffs ($t_{hs6,m,n}^0$) and evaluated according to equations 10 to 15 above. Further define $TPI_{i,r,s}^{NT}$, as the aggregated price assuming that all tariffs are equal to zero (full trade liberalization) and once again, estimated based on the equations above.

Then, the trade weighted tariffs based on expenditures, $TWE_{i,r,s}^0$, for the initial tariffs, $t_{hs6,m,n}^0$, are given by:

$$TWE_{i,r,s}^0 = \frac{TPI_{i,r,s}^0 - TPI_{i,r,s}^{NT}}{TPI_{i,r,s}^{NT}} \quad (16)$$

As discussed in the previous section, a new vector of tariffs ($t_{hs6,m,n}^1$) implies a new aggregated price, $TPI_{i,r,s}^1$, calculated based on equations 10 to 15. The associated trade weighted tariffs based on expenditure will then be calculated according to equation 17:

$$TWE_{i,r,s}^1 = \frac{[1 + TWE_{i,r,s}^0] \cdot TPI_{i,r,s}^1}{TPI_{i,r,s}^0} - 1 \quad (17)$$

This is the third indicator reported in the Excel spreadsheet “PivotTable”.

9 Dataset

The protection dataset provided in this tool is based on MacMapHS6v2.1 using 2004 protection and trade data. This dataset is described in [Boumellassa, Laborde and Mitaritonna \(2009\)](#) and used as a source of tariff information for the [GTAP 7 database](#), as described in [Laborde \(2009\)](#).

The database is composed of two files in txt format, used as inputs by the gams code:

- tariff.txt that contains the bilateral applied tariff information in the following format: “HS6 product code”.”ISO code exporter”.”ISO code IMPORTER” “ “ Ad Valorem Equivalent value for tariffs (decimal format).

Example:

220210.020.008	0.015843
220290.020.008	0.0093788
220421.032.008	0.0215958
220421.036.008	0.082242
220290.036.008	0.0197002

The first row of the file indicates that the AVE applied by 008 (Albania) on export from country 020 (Andorra) and for product 220210 (Beverage waters, sweetened or flavoured)

- trade.txt that contains the bilateral trade information in the following format:
- “HS6 product code”.”ISO code exporter”.”ISO code IMPORTER” “ “ trade for 2004 in millions of dollars (decimal format).

Due to the simple structure of the input files, it will be easy for the user to either:

- update some specific rows, in terms of tariffs and/or trade for some countries
- update the whole database using inputs from other sources (such as the World Bank’s WITS software).

When working with updated datasets, it is important to have a consistent (and updated) Excel file (*Free_Mapping* and *GTAP_Mapping* sheets) and nomenclature files. The current version is compatible with GTAP7:

- *rev1.inc* HS6 Nomenclature (list of HS6 code)
- *iso3d.inc* Country ISO 3-digit (currently the nomenclature used in MacMapHS6)
- *GTAP_R.inc* GTAP regions
- *GTAP_I.inc* GTAP sectors
- *Map_GT_I.inc* Sectoral mapping between HS6 products and GTAP sectors
- *Map_GT_R.inc* Regional mapping between country ISO code and GTAP regions

10 References

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