# The EU-GTAP conversion method: a numerical example

The present methodological description serves not only to make the existing process and results more understandable but also serves as the basis for future further developments of the method. The EU-GTAP conversion method consists of seven steps, which are comprehensively described in a numerical example and a flow chart provided in MS Excel (*0S2b\_Sup\_info\_Method.xls*). As regard data requirements for applying the EU-GTAP conversion method (*sheet Data*), the following input data are required for the numerical example:

* **GTAP Input-Output tables** of a base year (old version) distinguishing between domestic and import flows (e.g. GTAP9 version). In the numerical example, there are seven GTAP sectors (3 sectors for agriculture activities; refineries; other manufactured products; construction; and services); three final demand components (consumption, investment and exports); taxes less subsidies on products; and three value added categories (labour compensation, other net taxes on production and capital compensation).
* **ESTAT Input-Output Tables** at basic prices of the reference year (2010) distinguishing between domestic and import flows in NACE Rev.2. In the numerical example, there are six NACE sectors (agriculture; refineries; other manufactured products; construction, and 2 service sectors); taxes less subsidies on products; and the same final demand and value added components as in the GTAP IOTs of the base year.
* **Transformation matrices** (for domestic and import flows separately) from NACE Rev.2 into the GTAP-Profile cleaned (IMC) classification, which is actually a modified NACE Rev.2 version to account for changes in the classification system of sectors (from NACE Rev.1 to NACE Rev.2). The rows correspond to IMC sectors and the columns to NACE Rev.2 sectors, being the sum of each column equal to one in all cases. In the numerical example, 20% (25% for imports) of the NACE sector “refineries” is re-allocated to the NACE sector “other manufactured products” and 10% of the NACE sector “other manufactured products” (15% for imports) is re-allocated to the NACE sector “refineries”.
* **Foreign trade statistics** (exports/imports) by GTAP sector in the reference year (2010) using the most disaggregated data as possible (COMEXT). In the numerical example, the agricultural sector is disaggregated into three different GTAP sectors. In the numerical example, the distribution (shares) of exports and imports across the three different GTAP sectors are 97% for the exports of NACE/IMC agricultural products corresponding to GTAP sector 3, 2% for GTAP sector 2 and 1% for GTAP sector 1. For imports, the shares are 45%, 30% and 25%, respectively. All other cases had either one-to-one correspondences or many-to-one correspondences (e.g. services).
* **Gross output and value added** by GTAP sector (i.e. shares) using as much official statistics as possible (SBS, Agricultural Accounts, PRODCOM, etc.). In the numerical example, it is assumed that 60% of the output of the NACE/IMC agricultural sector came from the GTAP sector 3, 12% from the GTAP sector 2 and 28% from the GTAP sector 1. For value added, the shares are 55%, 20% and 25%, respectively. All other cases had either one-to-one correspondences or many-to-one correspondences (e.g. services).

Table 1 shows the description of the sectors in the different classification systems: GTAP, IMC and NACE Rev.2.

Table 1: Correspondence of classifications

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | **NACE Rev.2** | **IMC** | **GTAP** |
| Agriculture | nace1 | imc1 | gtap1+gtap2+gtap3 |
| Refineries | nace2\* | imc2 | gtap4 |
| Other manufactured products | nace3\* | imc3 | gtap5 |
| Construction | nace4 | imc4 | gtap6 |
| Services | nace5 + nace6 | imc5 + imc6 | gtap7 |

\* Part of nace2 should be re-allocated to other manufactured products and part of nace3 should be re-allocated to refineries

## Step 1: GTAP-Profile cleaning process

The first step of the process is the conversion from NACE Rev.2 into IMC classification by using the appropriate transformation matrices. We used the domestic transformation matrix to make the conversion of the rows and columns of the domestic IOTs while we used the import transformation matrix to convert the rows of the import IOTs. Instead, the columns of the import IOTs were converted using the domestic transformation matrix provided that imported inputs are still related to domestic production.

This was done in sheet *S1Prof*. The reader can check there that the re-allocations did not change the main totals (gross output, imports and value added) of the ESTAT IOTs.

## Step 2: Block-wise adjustment to the ESTAT IOTs

As a second step, we used the GTAP9 IOTs and re-scaled them to match the ESTAT IO data by blocks: agriculture, refineries, other manufactured products, construction and services (see Table 1). This was done in sheet *S2Bloc*. There are two main aspects to consider here:

1. Re-exports were originally set to zero in the GTAP9 IOTs while there was some information in the ESTAT IOTs; hence, we used import shares by GTAP sectors to fill the gaps. They were estimated from HS foreign trade statistics.
2. The eventual comparison between the ESTAT IOTs and the final GTAP IOTs will have to be done on the basis of IMC and GTAP sectors and, particularly, on the basis of the common sectorial aggregation shown in Table 1.

## Step 3: Estimation of total imports, gross output and value added by GTAP sectors

As a third step, we estimated the missing total values for imports, gross output and value added by GTAP sectors. The others were taken from more other detailed statistical sources as described in section 2.

1. For *imports*; we used shares provided by foreign trade statistics, which were then applied to the total imports of the corresponding IMC sector (from Step 2). In the numerical example, this was done for agricultural activities (imc1), which were decomposed into three GTAP sectors (gtap1, gtap2 and gtap3). This estimation was done in sheet *S3a-Impt*. The resulting values are the import totals by GTAP sector to be considered as target values in the final GTAP IOTs.
2. For *gross output*; the rows of the ESTAT IOTs (in IMC classification – from Step 1) were split up into GTAP sectors using the shares obtained in Step 2, which in turn come from benchmarked GTAP9 IOTs and (HS) foreign trade statistics. As a result, the sum of each row corresponded to the endogenously estimated gross output by GTAP sector. These resulting gross output were replaced whenever superior exogenous data became available. In the numerical example, we used existing exogenous shares of gross output to decompose the agricultural activities (imc1) into the corresponding three GTAP sectors (gtap1, gtap2 and gtap3). Hence, we have not used any endogenous estimation, although they are provided for the sake of completeness. This estimation was done in sheet *S3b-Out*. The resulting values are the gross output totals by GTAP sector to be considered as target values in the final GTAP IOTs.
3. For *value added*; in the numerical example, the value added of the three GTAP agricultural sectors have been obtained by applying shares of GTAP9 (adjusted) value added coefficients[[1]](#footnote-1) to the value added of the agricultural sector (imc1) of the ESTAT IOTs. The adjustment of the GTAP9 value added coefficients was made by multiplying them by the ratio: *(targeted)* *gross output by* *GTAP sector from Step 3b / gross output by GTAP sector from Step 2*. This estimation was done in sheet *S3c-Va*. The resulting values were the value added totals by GTAP sector to be considered as target values in the final GTAP IOTs. However, analogously to gross output, we have not used any endogenous estimation, although they were provided for the sake of completeness. We have assumed instead that there were official statistics on value added by GTAP sectors (i.e. gtap1, gtap2 and gtap3).

The main outcomes of the Step3 are the provision of target values for imports, gross output and value added by GTAP sectors, either endogenous or exogenously determined.

## Step 4: Adjustments of the modified GTAP IOT flows to the targeted gross output and total imports

In Step 4a, the domestic and import intermediate flows of the GTAP IOTs obtained from Step 2 were re-scaled *column-wise* by the ratio: *(targeted)* *gross output by* *GTAP sector from Step 3b / gross output from GTAP9 data*. Then ‘*gross output from S4a-Interm’* and ‘*import totals from S4a-Interm*’ were calculated as row-totals of the so ‘half-‘ (column-wise) modified domestic and import flows (including the unchanged final demand blocks) of the GTAP IOT. All these were done in sheet *S4a-Interm*.

Then, in Step 4b, the resulting GTAP IO table (from *S4a-Interm*) was again re-scaled but *row-wise* in order to get the targeted gross output and import totals by GTAP sector. The ratio applied to domestic uses was: *(targeted)* *gross output by* *GTAP sector from Step 3b / gross output from S4a-Interm*; while for imports: *(targeted)* *imports by* *GTAP sector from Step 3a / import totals from S4a-Interm*. This was done in sheet *S4b-Domr*.

## Step 5: Recalculation of the conversion coefficients

In the fifth step, demonstrated in sheet *S5RecTrf,* the rows of the ESTAT IOTs (in IMC classification – from Step 1) were split up into GTAP sectors using the (updated) shares or recalculated conversion coefficients calculated from the values of the GTAP IOTs modified in Step 4.

## Step 6: Estimation of the preliminary IOTs (priors)

The starting point of Step 6 was the semi-transformed ESTAT IO table (GTAP x IMC) obtained from Step 5. In Step 6, their columns were converted from IMC sectors to GTAP sectors using again the figures of the GTAP IOTs further modified in Step 4 to compute the conversion coefficients. However, now the shares were computed row-wise instead. Naturally the above conversion affects only the intermediate block of the semi-transformed ESTAT IOTs so that their final demand components must remain unchanged.

 For the value added, given the endogenous (or available) gross output estimated as described above, we computed capital compensation residually, as a difference between the gross output and the total estimated (domestic and imported) intermediate uses, TLS, labour compensation and other net taxes on production. We used SBS data to estimate the labour compensation components by GTAP sectors (shares) and the estimated/available gross output, value added or labour costs by GTAP sectors to allocate the other net taxes on production (shares). As mentioned earlier, the TLS values were estimated using an ad-hoc procedure, which is reported separately. However, there were exceptions whenever the capital values turned out to be negative and therefore, we estimated instead the labour cost as residual. Still, the problem may persist and therefore, we also provide normal (positive) capital shares using official data coming from National Accounts and SBS surveys.

The main outcomes of Step 6 were the so called “prior” ESTAT-GTAP IOTs. By construction (since practically they are the disaggregation of the profile-cleaned ESTAT IOTs) on the common aggregation level these ESTAT-GTAP IOTs are (‘block-wise’) consistent with the (profile cleaned) ESTAT IO data and are balanced from the perspectives of supply and demand. However, at the GTAP-sectors break-down they do not necessarily comply with: (see blue cells) targeted output, imports and value added. This is shown in sheet *S6Priors*.

## Step 7: Estimation of the final GTAP IOTs

The previous step provided ESTAT-GTAP IOTs that did not match the targeted values for totals of imports, gross output and value added by GTAP sectors. Hence, we defined a distance minimizing constrained two-matrix estimation model based on an objective function that minimizes the squared relative differences between the estimated and the prior ESTAT-GTAP IOTs subject to certain restrictions (Friedlander, 1961). The use of distance minimizing models is justified in the sense that we want to deviate the least from the prior ESTAT-GTAP IOTs in order to meet the targeted totals. Besides, it provides a flexible framework for adding (partly based on further statistics like the CAPRI database, additional information on the technologies, etc.) ad-hoc constraints on specific elements of the IOTs to be estimated (particular to one country), exemptions to non-negativity constraints and upper/lower bounds for inventories and export/output ratios, if needed.

 The general mathematical formulation of the model is described below (apart from the individual exemptions not listed here). We define the following sets: *I*, GTAP sectors (being the *i*-th and the *j*-th elements their row- and column-indexes, respectively); *V*, final demand categories (being *v*-th its general element); *B*, sectors classified according to the common aggregation level of the ESTAT-GTAP IOTs (being denoted as b and b’ when representing row- and column-indexes); and *M*(*b*,*i*), a mapping of the GTAP sectors into the sectors of the common aggregation level, i.e. the (*b*,*i*)-pair (of sectors) corresponds to the *i*-th GTAP sector and the *b*-th aggregate sector.

Regarding the variables to be estimated (normally non-negatives, with a notable exception the change in stocks), we have denoted **Dp**(*i*,*j*) as the intermediate (production) demand block of the domestic IOT; **Df**(*i*,*v*) as the final demand block of the domestic IOT; **Mp**(*i*,*j*) as the intermediate (production) demand block of the import IOT; and **Mf**(*i*,*v*) as the final demand block of the import IOT.

 The parameters are described below:

**x**(*i*) gross output of the *i*-th GTAP-sector

**m**(*i*) total imports of the *i*-th GTAP-sector

**v**(*i*) gross value added of the *i*-th GTAP-sector

*ε* arbitrary small scalar value (0.1 in the GAMS code)

*λ* arbitrary big scalar value (10 in the GAMS code)

$D\_{0}^{p}$(*i*,*j*) reference (prior) matrix for **Dp**(*i*,*j*)

$D\_{0}^{f}$(*i*,*v*) reference (prior) matrix for **Df**(*i*,*v*)

$M\_{0}^{p}$(*i*,*j*) reference (prior) matrix for **Mp**(*i*,*j*)

$M\_{0}^{f}$(*i*,*v*) reference (prior) matrix for **Mf**(*i*,*v*)

$D\_{a}^{p}$(*b*,*b*’) block-totals (at the common aggregation level) of the intermediate demand

block of the GTAP-profile-cleaned domestic IOT

$M\_{a}^{p}$(*b*,*b*’) block-totals (at the common aggregation level) of the intermediate demand

block of the GTAP-profile-cleaned import IOT

$D\_{a}^{f}$(*b*,*v*) block-totals (at the common aggregation level) of the final demand block of

the GTAP-profile-cleaned domestic IOT

$M\_{a}^{f}$(*b*,*v*) block-totals (at the common aggregation level) of the final demand block of

 the GTAP-profile-cleaned import IOT

 Then, we defined the minimisation problem as:



subject to[[2]](#footnote-2):















Note that the objective function has been adjusted with a scalar *ε* to allow zero initial values turning into non-zero values. Besides, we have avoided cases where big initial values may turn into very small values by computing relative errors with both variables and their reference values in the denominators of the objective function. A weighting scalar λ was introduced to counterbalance the fact that the number of final demand elements are much less than those of the intermediate demand. There are additional constraints representing the absolute and relative upper and lower bounds of exports, investment, stock variations and input coefficients.

 The full conversion process, including the model, has been coded in GAMS. In the numerical example, the sheet *S7Model* just describes the main features of the model while the sheet *Final* provides the final ESTAT-GTAP IOTs.

# References

Friedlander, D. (1961) A technique for estimating contingency tables, given marginal totals and some supplemental data, Journal of the Royal Statistical Society, Series A, 124, pp. 412–420.

1. Value added divided by gross output. [↑](#footnote-ref-1)
2. The | vertical bar in the following constraints represents the 'if', meaning that the summation is restricted to those elements of the set which meet the condition on the right hand side of the bar. [↑](#footnote-ref-2)