Further developments in the decomposition of the Eurostat net tax matrices and their transformation to GTAP format

Author: *Tamas Revesz* **– Corvinus University of Budapest**

Presenter: ***Tamas Revesz***

Further developments in the decomposition of the Eurostat net tax matrices and their transformation to GTAP format

Author

Tamas Revesz **– Corvinus University of Budapest**

Presenter ***Tamas Revesz***

Abstract

To supplement the GTAP9 data with detailed information on the taxes and subsidies on products the European Commission's Joint Research Centre (JRC) provided the most recent set of the Eurostat 'Taxes Less Subsidies on Products' (TLS) matrices compiled for 2010. The coverage was 27 EU Member States. For some countries some *components* (or 'layers') of the TLS matrix (concretely the VAT and Subsidy matrices) were also available, therefore in the decomposition process these also were taken into account. The country-specific TLS matrices (originally available in product by industry break-down) were decomposed to their VAT, excise tax, custom duty, 'other taxes on products' and subsidy components. This decomposition into multiple components goes beyond what is usually required for a GTAP data update. Nevertheless as taxation and pricing is one of the most important policy instruments, a higher degree of detail may make the EU data not only more suitable for tax policy analysis with multi-sectoral models, but also for energy, climate, agriculture and many other policy areas.

For Spain (ES), where the TLS matrix allegedly exists but is classified as *confidential*, the INSD bi-proportional matrix adjustment method was applied to estimate the TLS matrix itself by using the 2010 "Use matrix" as the reference matrix. This was rendered possible by the fact that the JRC also provided the "Use tables" for 27 EU-countries (missing only for BG). The JRC provided data also included the corresponding Input-Output tables (IOTs) themselves for all the 28 EU-countries and the 'Use Tables at basic prices' (Usebp or UF tables) for 26 countries. These were needed to compute the implicit effective tax rates.

For the decomposition many '*auxiliary' data* were acquired and processed. These data partly were downloadable from the Eurostat public database while others had to be obtained from the national statistical offices or other national statistics. The most important such databases were the 'Excise Revenue Tables' and 'National Tax List' data (NTL) of DG

TAXUD, the Eurostat's national accounts database and various publications of the national statistical offices, in particular their sometimes more detailed Supply and Use tables and occasionally available tax/subsidy matrices.

The TLS tables had to be transformed so as to match the *GTAP submission requirements*. These require the submission of the domestic and import products related TLS tables in GTAP-sector break-down only but not the TLS layers. However, to be able to estimate the TLS tables in GTAP-sector break-down reliably we had to transform its components (layers) *separately*.

The overview of the general decomposition and transformation method was presented in 2016 at the 19th Annual GTAP-conference (‘*Decomposition of the ESA2010 Eurostat net tax matrices and the transformation to GTAP format’*). This paper presents the *further development* of the *method* and the estimation *results*.

The paper is structured as follows:

Section 1 gives a short description of the background of the work and an introduction to the rather complex issue.

Section 2 presents the *data sources* and the main types of *data problems* like inconsistencies within and between the various datasets, heterogeneity of the country-specific datasets both in format and accounting methods, inconvenient data (e.g. negative values where nonnegative values are expected). Here some of the main estimating methods related *methodological considerations* are also highlighted.

In *Section 3 and 4* the new features of the *decomposition* and *transformation process* are discussed. These include the way how the Market Access Map (MacMap) custom duty data were used, how the sparse nature of certain TLS-layers (e.g. that of the custom duty-, VAT- and Subsidy matrix) could be exploited, how to deal with the apparent inconsistencies of the TLS matrix and the TLS row of the IOTs, how the original TLS tables (available in product by industry break-down) can be transformed to product by product break-down, how the GTAP profile cleaning of the TLS layers (which practically means the reallocation of certain subsectors to others) should be done, how the transformation of the IOTs at basic prices (UF tables) should be done integrated with the TLS tables (lest many weird implicit taxes rates show up as the consequence of that the split of the UF table of the C10-12 sector is done before considering the corresponding TLS figures), how to estimate the country-, use(r)- and TLS-layer-specific *transformation coefficient/share matrices,* how to identify a proper tax base for the rather heterogenous and mysterious ‘other taxes on products’, how to set reasonable lower and upper bounds (caps) for the implicit tax rates.

The last subsection of *Section 4* is devoted to the description of the elaborated *TLS-layers reconciliation model*, which separately for each country reconciles the (individually) transformed TLS layers with the aggregate TLS matrix (achieves the add-up consistency) and other external indirect tax data and which imposes all *balance requirements* and *other constraints* (implicit tax rates, proportions, block-totals, etc.) on the model estimates of the TLS layers in GTAP-sector break-down (in particular the estimated elements of the VAT-and Subsidy-matrices and the exports- and stock accumulations related taxes and subsidies). The model finds – separately for each country - such TLS-layers which are 'closest' to their priors, more precisely in which the *sum of the squared relative differences* between the model estimated and prior cell values is *minimal*. In this section it is also presented how the resulting TLS layers are *split to imported and domestic* commodities related parts.

The *numerical results* of the model estimates are presented and discussed in detail in *Section 5*. The paper concludes that despite the various data problems and methodological challenges, the model seems to have produced *reasonable results* (even for the subsidy matrix) for each EU countries. Investigation of this revealed that this is due to large extent to the fact that in most cells (one cell representing the use of a given product by a given user) the available 'net tax' figure contains only one or two types of taxes (the other TLS layers are zero), therefore the minimization of the relative distance (objective) function 'pulls' the distributable tax/subsidy amounts to the right cells (position) of the relevant TLS layer matrices, even without being informed about the precise tax mechanisms. The remaining problems are so few (about 1 % of the positive implicit tax rates of the estimated TLS-layers proved to be unrealistic) that one could compile easily a full list of them and carry through a one-by-one examination. This section also presents the preliminary results of a similar exercise done with the recently published *2015 Eurostat TLS-matrices*.

The last, '*Summary*' section argues that the results can be regarded to be quite novel and hopefully encouraging for other researchers (e.g. outside the EU) to apply this or similar method to estimate TLS-layers. A conclusion is drawn that a more direct benefit of the exercise was that during the process extensive and in-depth knowledge was accumulated of the country-specific *tax mechanisms and accounting practices*, which may be extremely useful in the *future revision/extension* of the TLS estimates. Also in the process a *transparent, reproducible* method (well-commented and maximally generalised GAMS-codes) as automated as possible (mainly using the GAMS GDXXRW facility and GAMS-Excel interface to read in the data and report the results) was developed.

Elaborating the transformation matrices from the IOT sectors to the GTAP-sectors helped to clarify the NACE Rev.2–GTAP sectors *correspondence*, which the GTAP-experts also welcomed as a good basis for the needed revision of the GTAP sector definitions so that they be compatible with the new NACE Rev.2/ISIC Rev.4 classifications.

The comprehensive database may be used in the calibration of a national or multiregional computable general equilibrium model which focuses on assessing the effects of tax and social policy reforms on demand for commodities, social groups and the government budget.

Keywords: GTAP database, Input-output tables, Supply and Use tables, product classifications, mapping different classifications, industry technology assumption, import matrix, matrix of taxes less subsidies, import duties, excise taxes, VAT, VAT-gap, tax exemptions, effective tax rates, implicit tax rates, tax system, tax base, National Tax List, disaggregation methods, estimating missing data, decomposition, transformation, data adjustments, data reconciliation, matrix balancing problem, block total constraints, mathematical programming, distance function, GAMS, slacks, constraints, lower and upper bounds, infeasibility,

1. Introduction

1.1. Background

According to Huff et al. (2000), submissions to GTAP should contain the so called UF tables (product by product IOTs) and UP tables (product by product IOTs including taxes less subsidies on products, IOT+TLS^{IOT}), both including separately domestic and imported uses of products. Consequently, the production of the UP tables requires the construction of product by product Taxes less Subsidies on Products tables (TLS^{IOT}), also distinguishing between 'Taxes Less Subsidies on Products' (TLS) levied on domestic and import transactions, separately.

To supplement the then most recent version of the GTAP database (called the GTAP9 database) with such TLS^{IOT} tables for the EU countries the European Commission's Joint Research Centre (JRC) provided the most recent set of the Eurostat TLS matrices compiled for 2010. However, the TLS tables transmitted by the EU Member States to Eurostat are in product by *industry* format (therefore, when necessary to distinguish them from the TLS^{IOT} tables, we will refer to them as the TLS^{USE} tables) so they had to be *transformed* into product by product format. Moreover, these TLS tables do not report TLS levied on domestic and import products separately (i.e. import tariffs and some subsidies/taxes on products). Therefore, these tables have to be *split* to domestic and import related parts accordingly.

However, to be able to estimate the TLS tables in GTAP-sector break-down reliably I had to transform its *components* (or 'layers') *separately*. For 15 EU-countries some components of the TLS matrix (concretely the VAT- and Subsidy matrices) were also delivered by the JRC.

The TLS tables had to be transformed so as to match the *GTAP submission requirements*. These require the submission of the domestic and import products related TLS tables in GTAP-sector break-down only but not the TLS layers.

The country-specific TLS matrices (originally available in product by industry break-down) were decomposed to their VAT, excise tax, custom duty, 'other taxes on products' and subsidy components so that they be consistent with the available official TLS tables.

This decomposition into multiple components goes beyond what is usually required for a GTAP data update. Nevertheless, as taxation and pricing are two of the most important policy instruments, a higher degree of detail may make the EU data not only more suitable for tax policy analysis with multi-sectoral models, but also for energy, climate, agriculture and many other policy areas.

The overview of the general decomposition and transformation method was presented in 2016 at the 19th Annual GTAP-conference (see Revesz (2016)). This paper presents the *further development* of the *method* and the estimation *results*.

1.2. Structure of the paper

The paper is structured as follows:

Section 1 gives a short description of the background of the work and an introduction to the rather complex issue.

Section 2 presents the *data sources* and the main types of *data problems* like inconsistencies within and between the various datasets, heterogeneity of the country-specific datasets both in format and accounting methods, inconvenient data (e.g. negative values where nonnegative values are expected). Here some of the main estimating methods related *methodological considerations* are also highlighted.

In *Section 3 and 4* the new features of the *decomposition* and *transformation process* are discussed. These include the way how the Market Access Map (MacMap) custom duty data were used, how the sparse nature of certain TLS-layers (e.g. that of the custom duty-, VAT- and Subsidy matrix) could be exploited, how to deal with the apparent inconsistencies of the TLS matrix and the TLS row of the IOTs, how the original TLS tables (available in product by industry break-down) can be transformed to product by product break-down, how the GTAP profile cleaning of the TLS layers (which practically means the reallocation of certain subsectors to others) should be done, how the transformation of the IOTs at basic prices (UF tables) should be done integrated with the TLS tables (lest many weird implicit taxes rates show up as the consequence of that the split of the UF table of the C10-12 sector is done before considering the corresponding TLS figures), how to estimate the country-, use(r)- and TLS-layer-specific *transformation coefficient/share matrices,* how to identify a proper tax base for the rather heterogenous and mysterious 'other taxes on products', how to set reasonable lower and upper bounds (caps) for the implicit tax rates.

The last subsection of *Section 4* is devoted to the description of the elaborated *TLS-layers reconciliation model*, which separately for each country reconciles the (individually) transformed TLS layers with the aggregate TLS matrix (achieves the add-up consistency) and other external indirect tax data and which imposes all *balance requirements* and *other constraints* (implicit tax rates, proportions, block-totals, etc.) on the model estimates of the TLS layers in GTAP-sector break-down (in particular the estimated elements of the VAT- and Subsidy-matrices and the exports- and stock accumulations related taxes and subsidies). The model finds – separately for each country - such TLS-layers which are 'closest' to their priors, more precisely in which the *sum of the squared relative differences* between the model estimated and prior cell values is *minimal*. In this section it is also presented how the resulting TLS layers are *split to imported and domestic* commodities related parts.

The *numerical results* of the model estimates are presented and discussed in detail in *Section 5*. The paper concludes that despite the various data problems and methodological challenges, the model seems to have produced *reasonable results* (even for the subsidy matrix) for each EU countries. Investigation of this revealed that this is due to large extent to the fact that in most cells (one cell representing the use of a given product by a given user) the available 'net tax' figure contains only one or two types of taxes (the other TLS layers are zero), therefore the minimization of the relative distance (objective) function 'pulls' the distributable tax/subsidy amounts to the right cells (position) of the relevant TLS layer matrices, even without being informed about the precise tax mechanisms. The remaining problems are so few (about 1 % of the positive implicit tax rates of the estimated TLS-layers proved to be unrealistic) that one could compile easily a full list of them and carry through a one-by-one examination. This section also presents the preliminary results of a similar exercise done with the recently published *2015 Eurostat TLS-matrices*.

The last, '*Summary*' section argues that the results can be regarded to be quite novel and hopefully encouraging for other researchers (e.g. outside the EU) to apply this or similar method to estimate TLS-layers. A conclusion is drawn that a more direct benefit of the exercise was that during the process extensive and in-depth knowledge was accumulated of the country-specific *tax mechanisms and accounting practices*, which may be extremely useful in the *future revision/extension* of the TLS estimates. Also in the process a *transparent, reproducible* method (well-commented and maximally generalised GAMS-codes) as automated as possible (mainly using the GAMS GDXXRW facility and GAMS-Excel interface to read in the data and report the results) was developed.

Elaborating the transformation matrices from the IOT sectors to the GTAP-sectors helped to clarify the NACE Rev.2–GTAP sectors *correspondence*, which the GTAP-experts also welcomed as a good basis for the needed revision of the GTAP sector definitions so that they be compatible with the new NACE Rev.2/ISIC Rev.4 classifications.

2. Data

2.1. Data sources

The JRC processed the acquired most recent set of the Eurostat TLS matrices compiled for 2010 according to the ESA2010 methodology. During the data processing it turned out that in many cases the **Supply and Use tables and the IOTs** (jointly referred to as SUIOTs) provided by the NSIs were inconsistent and not balanced, so the JRC and I had to do additional checks and, in some cases, report errors to Eurostat and the NSIs. As a matter of fact, the answers from NSIs were not fast enough.

The coverage of the JRC delivered set of **TLS^{USE} tables** was 27 EU Member States. For Spain, where the TLS matrix allegedly exists but is classified as confidential the RAS bi-proportional matrix adjustment method was applied[1] to estimate the TLS matrix using the 2010 "Use matrix" as the reference matrix. This was rendered possible by the fact that the JRC also provided the "Use tables" for 27 EU-countries (missing only for BG) to estimate the TLS matrix using the Use matrix of 2010 as the reference[2]. For Spain this method resulted in much more reasonable structures than the original RAS procedure (which in any case, cannot deal properly with zero margins and becomes unpredictable when negative values are in the reference matrix).

I also got access to the JRC CEIL Unit estimated **product by product TLS matrices**, and its column-totals, which I will refer to as the **IOT's TLS row**. These were probably estimated from the original product by industry TLS matrix by the usual Model B or the like, but certainly without considering the tax-type break-down (layers) of the tax matrix. In addition, for several countries the final demand related part of these matrices (IOT's TLS row) were

[1] See in: Analysis of budgetary and environmental policies by general equilibrium models (In Hungarian: Költségvetési és környezetpolitikák elemzése általános egyensúlyi modellekkel), Ph.D. thesis, Budapest University of Economic Sciences (Budapesti Közgazdaság–tudományi Egyetem), 2001.

[2] If the total net tax for a given product was negative like in the case of the agricultural and mining products and land transport) the additive-RAS-algorithm produced negative estimated TLS values for the whole row. Similarly, for the food industry, where the total net tax on the inputs were negative the estimated values of all elements of the food industry column of the TLS matrix became negative.

different from that of the product by industry TLS matrix, although in theory they should be the same[3]. We will discuss this issue later, in the section devoted to the methodological considerations.

The JRC provided data also included the corresponding Input-Output tables (IOTs) themselves for all the 28 EU-countries and the 'Use Tables at basic prices' (Usebp tables) for 26 countries. These were needed to compute the implicit effective tax rates.

Concerning the treatment of *confidentiality values* of the SUIOTs and of the TLS tables of Ireland, Lithuania, Poland and Sweden, the JRC estimated their missing values by applying the column/row structures of the EU consolidated IOTs published by Eurostat (Rueda et al (2016)).

In the dataset of **TLS layers** provided by the JRC for Austria (AT), Czech Republic (CZ), Germany (DE), Croatia (HR), Lithuania (LT), Malta (MT), Netherlands (NL), Poland (PL), Portugal (PT), Romania (RO), Sweden (SW) and Slovakia (SK) *both* the VAT- and the Subsidy matrix were available, while for Estonia (EE), France (FR) and United Kingdom (UK) only the VAT-matrix was available (apart from the aggregate TLS matrix).

These tables were collected, converted to GAMS gdx format, put together in a data file and provided to me by the JRC.

Apart from the JRC delivered datasets, for the decomposition many '*auxiliary*' data were acquired and processed. These data partly were downloadable from the Eurostat public database while others had to be obtained from the national statistical offices or other national statistics. These auxiliary data were also studied carefully and their consistency with the IOTs, Usebp and TLS matrices was checked. Since these latter cannot be changed (because they are official national accounts data and because their change would require a comprehensive rebalancing of these tables), any inconsistency was dealt with by adjusting the auxiliary data to them. The most important such databases were the following[4]:

2.1.1. TLS tables compiled still according to the ESA95 methodology

For Hungary I received the 'subsidies on products' matrix for 2010. Its author claims that the ESA95->ESA10 conversion did not affect the table (certainly the overall total remained the same in the national accounts). For BE, DE, PL and SK I also received the 2010 subsidy matrices and some other TLS layers compiled according to the ESA95 methodology.

2.1.2. National Accounts (NAs)

Eurostat provided data on National Accounts for all SNA categories (e.g. taxes, although with less detail) and institutional sectors (in national currency). Eurostat also provided the main National Accounts tax aggregates by country, broken down into rather detailed tax categories. It is also worth mentioning that it also included the taxes received by the EU institutions, e.g. a part of the VAT and the bulk of the import duties. The values from NAs may often differ due to different vintages of data revisions/submissions across countries. However, for our purposes, supplementary data from NAs/NTL/ were re-scaled to SUIOTs

[3] For example, for IE I observed that the available product by industry and product by product TLS matrices are more different than what could be explained by the Model B-like transformation.

[4] In square brackets the Eurostat database labels. In round brackets the name of the files containing the data.

totals in order to preserve a balanced Input-Output framework.

2.1.3. National Tax Lists (NTL)

The National Tax Lists published by DG TAXUD (ntl_release_2014.xls containing country sheets)[5] contained detailed lists of taxes, social contributions and related tax revenues according to national and System of National Accounts (SNA) classifications, often for the period 1995-2012. However, the lists were still far from being homogenous across countries in terms of the degree of detail and reporting periods, thus leading to time consuming manual adjustments. Our investigation of the Czech, Portuguese and Slovak data also occasionally revealed apparent differences and inconsistencies between the NTL and other sources (notably the TLS matrix or the National Accounts values). As a result, this project elaborated a reconciliation process that is described in detail in Section 4.5.

2.1.4. Excise taxes

The excise tax revenues by excise goods can be downloaded from the DG TAXUD webpage (European Commission, 2012a)[6]. In the case of energy products, additional information on rates and other auxiliary information (subsidies, VAT-rates) can be found in European Commission (2012b)[7].

2.1.5. Value Added Tax

The data on Value Added taxes (including the legal rates and the so-called VAT-gap) can be found in CASE (2013, 2014)[8], European Commission (2004)[9], European Commission (2012c)[10], European Commission (2009)[11] and Schneider (2010).

In the case of BG, IT and LU the *non-market output* data were not included in the Supply table. Therefore, for each of these countries I had to guess which sectors are “VAT-exempt”, i.e. which has to pay the VAT on their inputs. Although this method is far from being too sophisticated and perfect, without this the decomposition model estimated a VAT-prior matrix in which the intermediate block was 0.

2.1.6. Agriculture and food industry specific data

The following information was used to deal with agricultural and food industry data related to taxes and subsidies on products: Britz and Witzke (2012), OECD (2014) for subsidies on products, mainly for agriculture and the Eurostat’s databases on Economic Accounts for Agriculture, Structural Business Statistics by industry (NACE Rev. 2, B-E) and enterprises (e.g. food sector) and other related Eurostat databases.

2.1.7. Other data sources

Although not exhaustive, these were additional data sources used for various purposes in

---

[5] http://ec.europa.eu/taxation_customs/taxation/gen_info/economic_analysis/tax_structures/article_5985_en.htm
[6] excise_duties_energy_products_en.pdf, excise_duties_alcohol_en.pdf, excise_duties_tobacco_en.pdf
[7] excise_duties-part_II_energy_products-en-2010.pdf
[8] vat_gap2012.pdf
[9] vat_indicators.pdf
[10] vat_rates_en-2010.pdf
[11] VAT-reckon_report_sep2009.pdf

the decomposition process:

a) Investment by institutional sectors (download from the nasa_nf_tr coded section of the Eurostat database)[12];

b) Environmentally Related Taxes, Fees and Charges - Revenues raised by environmentally related taxes for selected countries – OECD database[13]. This information was essential to allocate product taxes correctly on the products where they were levied. Some of these environmental tax revenues may belong to the "other taxes on production", which is part of the gross value added and not part of the "taxes on products", as stated in the SNA08;

c) Eurostat's National Accounts Main Aggregates; consumption expenditures by COICOP categories [nama_co3_c] were used to compute the average VAT rates for some CPA products and to estimate the excise taxes paid by households[14];

d) Eurostat's annual exchange rates between national currencies against the Euro and the US dollar (AMECO database)[15];

e) Other country specific data sources such as for Hungary and the Czech Republic: longer lists of tax revenues by products; more detailed Supply and Use tables, and investment matrices by asset and institutional sectors.

f) Import tariff revenue estimates based on the **MacMap**[16] (bounds) (provided by JRC)

2.2. Problems of the data

Apart from the mentioned missing or partly confidential SUIOT and TLS data, I had to face many other types of problems with the acquired data. Just to illustrate the difficulties of the task I outline the main types of data problems[17]:

1. Heterogeneity of the format (including the location of the same categories, different details, e.g. if the change in valuables /P53/ is reported separately from the change in stocks /P52/ and if not reported separately, whether their sum shows up in the P52 column or only in the P5M column) and labels, wrong translations (e.g. in the National Tax List – to be referred as NTL - worksheet for Denmark the D214FB coded 'Omsætningsafgift af tipning' was officially translated erroneously as 'sales tax on football pools' although it turned out to be almost certainly a tax on tipping), different decimal digit roundings, etc.
2. Heterogeneity of the accounting methods (e.g. stamp duties on property transactions are accounted on construction, real estate services, insurance, legal services or on other sectors, whether VAT is accounted on exports, whether tax is accounted on stock

[12] INV-EU-nasa.xls
[13] http://www2.oecd.org/ecoinst/queries/Query_2.aspx?QryCtx=2 (stored in the EnvTaxHu.xlsx file)
[14] nama_co3_c_eur.xls
[15] AMECO13.xlsx
[16] see ITC (2016)
[17] More concrete such data problems will be mentioned in a separate report.

accumulation and government consumption, how find out where the confidential sectors are accounted, questionable accounting of the services of the leased ships of Cyprus[18], in the earlier versions of the received CZ and RO Subsidy matrices the nonzero elements were negative[19], etc.)

3. Inconvenient data values according to GTAP submission guidelines: e.g. negative values in the column of exports and in the row of the value added are not permitted.
4. Internal inconsistency of the data: data do not add up (e.g. in the Maltese TLS layer matrices the components related to the refinery products input of the health care do not add up to the total), imbalanced, values out of proportion (export shares, tax rates, VAT-rates, etc.)
5. External inconsistency (with other data, e.g. in Greek TLS_{USE} matrix tax is accounted on exports but not in the IOT, in the UK TLS row-total for C10-12, the NTL figures are sometimes different from National Account figures and from the IOT)
6. Currency conversion problems (data may be in ‚euro-fixed' exchange rates, TAXUD uses the October 1 exchange rates to compute the euro value of the excise tax revenues, which therefore may be different from the one computed by the Eurostat's annual exchange rates)
7. Different vintages of the 2010 data (unlike in the UN submissions, the vintage – i.e. which data belong to the same version of the national accounts - are not listed)

In the following subsections we review the most important or interesting data problems by data categories.

2.2.1. Inconsistency and other data problems of the IOT

In the file of the set of the last received IOTs[20] for Ireland (IE) the stock accumulation of domestic and imported trade and repair services of motor vehicles (71 and 0 M € respectively) do not add up to the reported total (0 M €)[21]. Therefore, in the 'A-type' IOT, where domestic and import uses are added together, the true row-totals of the domestic IOT (1889 M €) is less than the official gross outputs (1961 M €). Since in the corresponding Use table for IE[22] all trade related stock accumulation is zero, the discrepancy was probably generated in the process of separating out the trade margin and distributing it to domestic and imported components.

[18] As a consequence a tremendously high negative value added is accounted in the Input-Output table for the H50 coded water transport sector. The official explanation is that 'the ship owning companies are coded in H50 NACE, however due to the fact that the majority of them lease their ships to others, most of their production is assigned to product "77.3" – "Rental and leasing services of other machinery, equipment and tangible goods".' In my view, however, they do not seem to have followed the SNA guidelines: when reallocating the output the related (or at least proportional) part of the costs should have been reallocated too.

[19] Although methodologically it is not a too important issue but it caused much trouble (mostly before this was eventually detected) and clearly showed that we received the data without a serious scrutiny of their accounting uniformity.

[20] io_tables_eur_Final-V7.gdx file dated from 12/09/2016

[21] see the intersection of row G45 and column P52 in the 'Total' matrix for IE in the io_tables_eur_Final-V7.gdx file

[22] see in the SUTs_EUR_Group_Final_V4.gdx file, which is dated from 15/07/2016

In the same set of IOTs, for SE a small negative amount (-1.3 M €) is reported as the households' consumption of imported mining products[23].

For CY, in the earlier version(s) of the received IOTs the (C25/P3_S14) element of the domestic IOT is seriously negative (-57 M €)[24] which was just counterbalanced by the corresponding import demand (78 M €). However, since the GTAP-profile cleaning removed a higher proportion of the import demand than from the domestic one, the resulting "profile cleaned" total (domestic+import) demand in this cell became negative (-57+48 = -9 M euro). Therefore, the tax bases also became negative resulting in weird implicit tax rates. This highlights the importance of eliminating unjustifiable negative demands from the original data even if at the first glance they do not seem to be fatal.

As I learned from the Eurostat, the cause of the problem was that there was a formula in the applied tool incorrectly assuming zero final consumption expenditure by government from imports (Table 1612).

However, even in the most recent IOT for CY an extremely negative value added figure (-1002 M €, almost four times higher than the gross output) is reported in the water transport sector (coded H50). The explanation is that the ship owning companies are registered in the water transport sector, however due to the fact that the majority of them lease their ships to others, most of their output is assigned to product "77.3" – "Rental and leasing services of other machinery, equipment and tangible goods". Apparently, the primary activity is not profitable at all, and when the output and the (positive) value added of such secondary activities were removed to build the product by product dimension IOT, the seriously negative value added of the water transport sector's principal activity was revealed.

As mentioned, *negative amounts* reported in theoretically non-negative categories like consumption, exports and gross fixed capital formation caused much problems in the decomposition and transformation process. Such phenomena were observed in the following cases:

For Greece (EL) *negative private consumption* is reported of many imported services (-121 M € of the accommodation and food services, -0,1 M € of the auxiliary financial services, -9.9 M € of the rental and leasing services, -4.7 M € of the travel agencies services, -34 M € of the sport-amusement-recreation services and -2.4 M € of the services of membership organisations). However, when we add together the consumption of the corresponding domestic and import goods, no negative elements can be observed in these sums. Therefore, one may suspect that the negative figures may be the result of an improper split of the reported consumption expenditures into domestic and import components.

The printing products (coded C18) and miscellaneous business support services (coded N80-82) related elements of the household consumption column of the FR VAT matrix were seriously negative (-22 and -647 M euro respectively).

[23] see the intersection of row CPA_B and column P3_S14 in the 'Import' matrix for SE in the io_tables_eur_Final-V7.gdx file
[24] see even in the io_tables_eur_Final-V6.gdx file (dated 19/07/2016) in the intersection of row CPA_C25 and column P3_S14 in the 'Domestic' matrix for CY.

For Denmark (DK) negative private consumption (-11.5 M €) is reported of the domestic 'other transport equipments' (C30). The answer for this mystery was that during the 'financial crisis' many Danish households had to sell their motorboats to Swedish people, and this was accounted as negative consumption (and presumably as positive export).

Also for Denmark, *negative gross fixed capital formation* (GFCF) was reported of agricultural products (-6.7 M € for the domestic and -0.4 M € for the imported parts) and of imported basic metals (1.7 M €).

For Ireland (IE), also negative gross fixed capital formation was reported of agricultural products (-40 M € for the domestic and -10 M € for the imported parts) and of the accommodation and food services (-0.1 M € for the domestic and -0.8 M € for the imported parts), whatever the real meaning of such service imports is.

For Italy (IT) a slightly negative investment (-0.3 M €) is reported of the domestic products of the fishing and aquaculture activities.

2.2.2. Inconsistency of the IOT and the TLS matrix

The inconsistency of the original IOT and TLS tables could be detected by computing the implicit tax rates. For example, in the case of LU the construction related net tax (in the TLS^{use} matrix) in the imputed rent column is 26 M €, while the corresponding IOT figure is zero. moreover, surprisingly the whole column of the imputed rent is zero, i.e. all related taxes were reallocated to the columns of other products. This makes one wonder how the TLS^{cxc} table was produced for LU: if the TLS table accounts 26 M € tax in the L68A column, then some L68A industry-activity (output) should be behind. When reclassifying it to product by product table this L68A industry-activity should belong to/remain in - by construction - the L68A product-activity. This must be so, because this is imputed, i.e. artificial activity, where there is no difference between the product and the industry (organisation).

For PL this mismatch problem also surfaced in the real estate services sectors: according to the IOT the electricity-gas-heat supply received 3898 M € from the L68B coded real estate services after which the TLS^{cxc} matrix duly shows 771 M € tax payment. However, in the TLS^{USE} matrix nothing is accounted in the corresponding cell. Instead, 738 M € is accounted as electricity-gas-heat consumption related (only VAT) tax paid by the L68A coded imputed rent activity. Although this is in accordance with the 4486 M € reported in the corresponding cell of the Use table (implying a 738/4486= 16,5 % tax content or 738/(4486-738) = 20 % effective VAT rate), the question remains: Why both the transaction value and the tax amount figures related to the electricity-gas-heat consumption of the imputed rent activity were shifted to the other real estate services while compiling the allegedly product by product IOT?

2.2.3. Internal inconsistency of the TLS layers

In September 2016, eventually I have received the final (V10) version of the file containing the TLS^{USE}, TLS^{cxc} matrices and the available TLS-layers. In this dataset the TLS layers seem to be consistent with each other and their corresponding elements (i.e. for each cell the sum of their figures) they add up to the corresponding element of the TLS^{USE} matrix.

However, in earlier version some apparent add-up inconsistencies were observed. They turned out to be due to the availability of the different TLS layers in different currencies. In the TLS data files all TLS layers were supposed to be (already) in millions of Euros. However, when integrating gradually the newly acquired TLS layers (delivered by the NSIs usually in their national currency) sometimes this conversion was forgotten.

This happened in the case of PL (before the V8 version), SE, MT, RO and LT (in the V6 version).

2.2.4. Inconsistency with the excise tax data

In addition for many countries (FR, PL, PT, RO, SE, SK and UK), the TAXUD data based excise tax revenue figures (in most of the cases for the C19 refinery products but for SK and the UK also for the C10-12 food-beverage-tobacco products) had to be cut more-less to fit into the lower figure for the corresponding row-total of the gross tax matrix (TLS+Subsidy).

For SE, SK and the UK the VAT matrix was available and for SE and SK the subsidy matrix too. Therefore the non-VAT taxes could be computed from the TLS data file (available in gdx format). However, in each of these cases the C19 related non-VAT taxes proved to be lower than the corresponding TAXUD/NTL excise tax data. This inconsistency could be eliminated only by cutting the TAXUD/NTL figures by the corresponding discrepancy. In the case of SK it was minimal (8 M euro), for SE 2.5 % (1185 M SEK) and for the UK 8 % (2202 M £). Note the in the case of the UK the C10-12 related TAXUD/NTL excise tax data also had to be cut by 2.5 % (427 M £) for similar reasons. Also note, that in the TLS (gdx-file) data the total UK VAT is reported to have been only 87295 M £ (101766 M euro) as opposed to the 95865 M £ figure in the national accounts/NTL.

As usual, these discrepancies also show up in the estimated "other taxes on products".

2.2.5. VAT data problems

Also note that in the VAT matrices, the whole VAT revenue (as reported in the national accounts) is accounted for, although VAT is also collected after the turnover of second-hand property (which does not appear in the current IOT).

Furthermore, in the G45 row of the VAT matrix of Romania, many (although small) negative elements can be found (related to the A02, B, C10-12, C28, D, H50, N77, N78, R90-92, S95 and S96 coded sectors). For RO a small additional problem is that the C22->L68A and C31_32->L68A elements of the VAT matrix are slightly negative.

More seriously, in the last submission of the MT TLS layers the VAT on the construction service inputs of the L68B sector (“Real estate services without the imputed rent”) is significantly negative (-1.34 M €) at least relative to the size of the Maltese economy. Apparently, the cause of this is that the splits of the individual TLS layers of the total real estate services (L68) were not done consistently with each other.

More seriously, the C18 and N80-82 sectors related elements of the household consumption column of the FR VAT matrix were seriously negative (-22 and -647 M euro respectively). In the decomposition program for FR, I had to circumvent the problem of negative value added tax by introducing a negative component of the VAT (as a parameter in the GAMS code) so that the non-negativity constraint of the VAT variable may be maintained. Then, I also had to "transform" these constraints to GTAP-sectors to be used in the TLS-transformation model.

2.2.6. Import duty data problems

For all but EL and LV sum of the MacMap's so-called "minimum import duty revenues" turned out to be higher than the corresponding national account figure (D.2121):

Table 1. **Custom duties in million euros**

EU country code	National Accounts	MacMapMin
AT	218	262
BE	1210	2145
BG	82	95
CY	36	40
CZ	6547	7518
DE	4130	4588
DK	3241	3639
EE	24	24
ES	1591	1634
FI	151	168
FR	2170	2267
EL	279	278
HU	33420	71266
IE	229	246
IT	2225	2331
LT	182	214
LU	18	19
LV	25	22
MT	13	25
NL	1727	2603
PL	1694	1960
PT	158	195
RO	592	642
SE	5412	5943
SI	59	124
SK	142	236
UK	2933	3223

Source: A73:AF74 range of the ImpDuty sheet of the TaxDecIn.xlsx file

Therefore these (pseudo-) minimum duty revenues were not used as lower bounds.

Clearly one option is that one may adjust the estimates proportionately to fit into the national account totals.

Note, that for Croatia MacMap data were not available.

RO is also problematic because the import duties - exceptionally for RO - include the D.2122 "other taxes on imports" too. The main reason for this is that in the TEMPO database[25], they publish the product break-down of this augmented category and in the future refinement of the model, I may use this information more extensively (so far it is used only to compute the prior for the duty matrix).

2.2.7. Summary of the data problems

Despite of these problems the compiled database is much more comprehensive and suitable for the GTAP database than anything before.

2.3. Data related methodological considerations and corrections

2.3.1. Data corrections

Checks of the consistency of the model estimated total net tax with the sum of the priors and the official total(s) respectively have been made as well as checks if the totals of the model estimated layers add up. Small (less than 10 M €) overall discrepancy is usually allowed by the decomposition and transformation models to deal with the rounding inconsistencies and the few exceptions from the strict balancing criteria (these exemptions are mostly made when the official statistics based target value is negative but the matching variable is declared to be as non-negative).

2.3.2. Dealing with small values

In theory, the estimated (transformed) figures of the tax- and subsidy matrices could be modified for example by the so called rooking method, which leaves both the row- and column-totals intact. However, unless one makes only small (proportional) adjustments, changing the tax/subsidy estimation (transformation) results unilaterally is somewhat risky. If the corresponding IOT estimates are not changed too accordingly then the implicit tax rates may be distorted for a number of cells where the IOT has changed significantly (in percentage terms).

2.3.3. Reconciling the IOT and TLS estimates

First of all we have to bear in mind that the product by product IOT's TLS row is just an estimate (made by Model B assuming implicitly uniform (net!) tax rates across the reallocable parts of the same industry) made on the aggregate level (not considering the TLS layers, e.g. that which product of the individual industries are subsidized). Since this reclassification of the intermediate uses from industry to products (practically the reallocation of the secondary-products-related taxes and subsidies of the columns of the intermediate demand-related block) was done differently (in any case independently) from how we reclassify the product by industry TLS layers to product by product dimension, already in the original (Eurostat) IOT-

[25] http://statistici.insse.ro/shop/index.jsp?page=tempo2&lang=ro&context=35

sector break-down we can observe some differences between the two estimates (i.e. between the product by product IOT's TLS row and the column totals of the product by product TLS matrix reconstructed as sum of its already reclassified components).

2.4. Specification of the decomposition software

The data processing and the decomposition were carried through by developing and using a GAMS-program (TaxDecom.gms). Since the individual Member States (MS) have occasional, methodological and format differences in their statistics and tax/subsidy system, apart from the general program country-specific programs were also elaborated (TaxDecomPL.gms, TaxDecomDE.gms, TaxDecomHU.gms) but subsequently and gradually integrated into/with the general decomposition program.

3. The decomposition process

The estimation process consisted of the following main phases:

1. Estimating the *row-totals* (totals by products) for the component matrices (TLS layers),
2. Estimating satisfactory *priors* for each TLS layer,
3. Elaborating a *matrix-distance minimizing model* to simultaneously and consistently estimate the *TLS layers*.

The above phases consisted of the following detailed steps:

3.1. Estimating the row-totals of each TLS layer

In estimating the *row-totals* of each TLS layer the main data sources were: the 'Excise Revenue Tables' and 'National Tax List' data (NTL) of DG TAXUD, the Eurostat's national accounts database and various publications of the national statistical offices, in particular their sometimes more detailed Supply and Use tables and occasionally available tax/subsidy matrices.

Fortunately, in most MSs the '*other product taxes*' are not too significant and there are only a few such tax categories. These are listed in the NTLs. For each country, each tax category had to be allocated to products. In most cases (gambling tax, insurance tax, coffee excise tax, fees on entry tickets, etc.) this was straightforward. However, many of other types of taxes (notably stamp duties, general sales taxes, environmental taxes, the Romanian "special fees", or the Spanish "duty on specific means of transport" and "excise duty on certain imported products") needed further studies to find the affected products. For Hungary the allocation (matching) was based on an earlier JRC study (Révész, 2014).

Unfortunately, apparently the statistical offices of the Member States (MSs) are also somewhat puzzled about the affected products (especially if they are expected to allocate even the second hand products related product taxes to the use of the current sources – production and imports – of products). Since it has become obvious that even in the case of similar taxes the MSs allocate them to different products and users (e.g. the German Statistical office allocates the duties on acquisition of property to the L69 coded "legal services,…", while the Hungarian Statistical Office allocates it partly to construction, partly to the motor vehicles) I had to take into account these accounting differences in the estimation method by allocating them directly to the corresponding cell of the matrix.

3.2. Estimating satisfactory priors for each TLS layer

In estimating satisfactory *priors* for the TLS layers, the quite "sparse" nature of these matrices was an advantage. For example, VAT is paid mostly by the household sector and the budgetary institutions. The excise tax matrix includes only the quantity based 'EU-harmonized' excises taxes on alcoholic beverages, tobacco products and motor fuels. The custom duties concentrate on the manufacturing products, notably on textile, chemical and food products.

In the following sub-sections we outline the methodology used to split the total Taxes less Subsidies tables (TLS) into Value-Added Tax (VAT), Excise taxes (ET), Other taxes on Products (OT), Import Duties (ID) and Subsidies on Products (SP) tables.

3.2.1. Excise Taxes

I decided to start with excise taxes the estimation of the breakdown of TLS tables for the following reasons. Excise taxes are mostly concentrated on a few products (energy, tobacco, alcohol and fuels). In fact, there may be many less significant excise tax-like (not refundable quantity based) taxes, but I decided to include into the excise tax matrix only the so called 'EU-harmonised' excises, i.e. the excise taxes on alcohol, tobacco and fuels. For such harmonised excise taxes (and similar duties), DG TAXUD publishes both the rates and the generated revenues (European Commission (2012a), European Commission, (2012b) and European Commission (2014)) by product. However, they do not publish the data with information on users, which is highly recommendable to estimate individual user’s shares in the total amount of the tax generated.

Unfortunately, the current breakdown of products in the available Use Tables shows food, beverages and tobacco altogether. Similarly, the mining industry is also one single product/activity, therefore, in theory, it cannot be used to allocate the *coal, gas* or *electricity* related excise taxes across different users. However, such excise taxes are negligible in the EU therefore to distribute the gas and coal related harmonized *excise taxes* (and the electricity related excise taxes) the proportions of the row of the mining sector in the Use (or IO) table were used.

With respect to tobacco, alcohol and refinery products, I have used further detailed Use tables (e.g. CZ, HU) to derive different user shares of the excise tax revenues. First by using available data for reference countries (Czech Republic, Hungary) I computed the user-specific alcohol- and tobacco excise tax *shares* in the total expenditure on the CPA10-12 products and the user-specific motor-fuel excise-tax liable *shares* in the total expenditure on the refinery products. Then these shares were *scaled-up* by the corresponding consumption levels. Finally, these rough excise tax estimates were benchmarked (*adjusted proportionately*) to the corresponding National Accounts totals (alcohol-, tobacco- or motor fuel-related total excise tax revenues), whenever available to ensure consistency. Given such totals, the underlying assumption of using CZ and HU structures for all Member States is that the industry-specific excise tax shares and their allocation structure along the row of the table are regular across Member States. This seems quite realistic since the user shares of such commodities (Tobacco and Alcohol beverages) are mainly households and restaurants across the EU.

Naturally based on available direct information on the structure of the tax revenues it was necessary to enforce certain *caps* on the (user-specific) other product taxes and excise tax estimates, but since these "other taxes on products" are more complex and their mechanisms are less clear, it was more difficult to identify a proper tax base to compute the reasonable lower and upper bounds of the implicit tax rates.

3.2.2. Value Added Tax

The construction of the initial subsidy and *VAT-matrices* required much attention. The estimation of the effective VAT-base took into account the share of the black economy, the various thresholds, exemptions, discounts, user-specific VAT-rates, and other facts such as whether VAT is accounted on the inventory changes and the exports. The estimation of the initial VAT matrix was done following three steps:

- Estimation of average effective VAT rates
- Estimation of VAT base
- Estimation of the VAT table

For each of the 64 products of the Eurostat SUIOTs, a set of **average effective VAT rates** was estimated, mostly based on the DG TAXUD VAT rates publication (European Commission (2012c)). These average rates were refined using weights based on consumption statistics and households' budget surveys data, wherever possible (and most of the time with CZ, as reference country[26]).

For the construction of a **VAT base**, it is very important to know that not all the elements of the intermediate and final uses are liable to VAT, such as for instance the exports and most of the investments. In general, the VAT levied on intermediate inputs can be claimed back by those corporations that produce market-output. However, the VAT levied on the intermediate inputs of *non-market outputs* of industries usually cannot be claimed back (therefore, they have to bear the costs). Similar explanation also applies to the *VAT exempt* industries, like financial services. In addition, sales of VAT exempted commodities or of non-market commodities will not be paid to the seller. On the other hand, *imported goods and services* must be included in the tax base because they are liable to VAT. Finally, no VAT is collected after the transactions of the *hidden economy*.

The calculation of the VAT tax bases of *investments* needed additional adjustments to account for the share of VAT that investors can claim back. In particular, I estimated the investment column vector of the VAT matrix starting from investment matrices by asset (a) and industry (h), k_{ah}, available in the Eurostat database. They include 20 industries (sections of the NACE Rev.2 classification) and 9 assets (AN_F6 classification).

[26] We will use VAT data for all EU countries. However, when the total value of taxes paid refers to two or more GTAP categories, we have to find a way to split up the taxes paid by each product. In doing so, we use the CZ households' budget surveys data (as a reference country) because it is the only country that provides such detailed disaggregation. The reader must also be aware that CZ is the only country that publishes the VAT and other components of the TLS by sector in the Supply table. For these reasons, we have used it as a reference country, which does not mean that our results will replicate CZ VAT economic structures.

Ideally, an *investment matrix* with elements k^s_{ah} by asset (*a*), industry (*h*) and institutional sector (*s*) is needed to estimate the share of the exempted VAT corporate investment (*c*) over the total investment demand. However, these were available only for a few countries such as the Czech Republic and Hungary. So, I had to use these tables to estimate the shares of corporate sectors in the investment demand for a given product. Besides, I had to match asset types with CPA products (change from sub index *a* to *i*) to be able to apply the corresponding corporate investment shares (Table 4.2). This process was tested and it provided results very close to the totals provided by the Eurostat's Sectorial Accounts.

Finally, I computed the **VAT matrix**. The VAT rates applicable in EU countries by commodity were multiplied by the corresponding VAT base estimates represented by the elements of *b*. However, I set a limit so that for the usually non-subsidised commodities, the estimated commodity and user specific VAT should not exceed the corresponding figure in the TLS (since VAT is just one component of the total indirect taxes).

I have used two DG TAXUD publications (CASE (2013) and CASE (2014), Appendix A (from p.101)) to build lower bounds of investment shares related to non-deductible VAT and upper bounds to households' consumption VAT shares. This avoids biased estimates of VAT matrices in terms of the individual user's shares in the overall total VAT revenues. They were also used in the next step to reconcile all the estimated decompositions of the TLS tables.

For some countries the model-estimated VAT-matrix turned out to be unrealistic or even its overall totals could not reach the target (i.e. national accounts figure for the total VAT revenues).

Independently from the issue of the non-market output data, for some countries the model could not allocate enough tax revenue to the VAT. In these cases either in the intermediate demand or the final demand (or in both) the cap was increased on the implicit VAT (rate). In some cases this can be justified not only by this technical necessity but also by referring to the fact that the estimated VAT-base (basic price+excise+other tax computed from the priors[27]) may not make up the true base (which certainly includes the duties, and which - in the real life - may be different from what is in the SUIOTs anyway).

3.2.3. Subsidies on Products

In the case of the *subsidies* even the totals by products are normally missing from the official statistics.

The official available matrices of subsidies on products are usually quite *sparse* with a very specific structure, where subsidies are highly concentrated in agriculture, energy and transport services. For this reason, the initial estimation of such matrix (S) was done using the matrix distance minimizing model, which minimized the sum of the squared percentage differences between the estimated and the initial (prior) values of the elements of the matrix of subsidies on products so that the resulting matrix match the total subsidies on products reported by National Accounts in each EU Member State. This prior matrix was constructed in the following sophisticated way:

[27] Using the priors instead of the (to be) estimated values was made necessary by the fact that the GAMS does not allow using variables in conditional criteria.

First, I computed the average values (or rates) of the five then available subsidy matrices (i.e. of the BE, DE, HU, PL and SK subsidy matrices)[28]. In the second step I adjusted this *reference* matrix (denoted by S^0) for every EU State to fit to the available data for the given country.

These (element –wise) adjustments were the following, where U and S denote the Use Table (at basic prices) and the prior Subsidy matrix (to be estimated) respectively:

1) If the corresponding element of the Use table or the TLS matrix was *zero* ($u_{i,j} = 0$ or $tls_{i,j} = 0$), then I set the adjusted matrix of subsidies on products to zero ($s_{i,j} = 0$, regarding it to be highly unlikely that in the given cell the subsidies and taxes just cancelled out each other, even if $s^0_{i,j} > 0$, i.e. subsidies were allowed in the reference matrix);
2) If the corresponding element of the TLS matrix was *negative* ($tls_{i,j} < 0$), then I set the given element of the adjusted matrix of subsidies on products to the absolute value of the element of TLS matrix ($s_{i,j} = | tls_{i,j} |$);
3) After subtracting the sum of the absolute value of the negative elements of the TLS matrix from (or in other words after adding the negative elements of the TLS matrix to) the aggregate figure of the subsidies (overall total of the subsidy matrix) and the possibly available row-totals of the subsidy matrix (i.e. the subsidies by products), the *remaining* subsidies were distributed among the other elements of the subsidy matrix *proportionately*. Concretely this proportionately meant that
3a) if there were given the row-totals of the subsidy matrix then the remaining row-totals were distributed row-wise proportionately to the elements of the corresponding row of the reference matrix, or if these latter were zeros (i.e. $s^0_{i,j} = 0$ for all j where $tls_{i,j} \geq 0$) then proportionately to the figures of the row of the use matrix.
3b) if there were given the row-totals of the subsidy matrix then the remaining overall total subsidy was distributed proportionately to those $s^0_{i,j}$ elements of the reference matrix were both the Use table and the reference matrix were positive ($u_{i,j} > 0$ and $s^0_{i,j} > 0$), assuming their same share (as in the reference matrix) in the total value of subsidies in the economy.

In the case of BG the TLS matrix is inconsistent with the national accounts figure for the total subsidies, since already the sum of its negative elements (representing the minimum of the subsidies in that cell) is greater than the national accounts figure. Therefore, I assumed that the subsidies are located here so that their value is equal to the absolute value of these negative elements. The difference – as usual – was accounted against the 'other taxes'.

After having constructed the prior for the subsidy matrix, in the subsidy-matrix distance minimizing model I put similar constraints and additional constraints provided extra information from other data sources was obtained. These were the following:

1) If row-totals (subsidies by products) were available, they must be used as benchmark for the estimated matrix of subsidies on products. If row-totals (subsidies by products) were not available, the resulting overall total must be equal to the aggregate figure published by National accounts.

[28] other subsidy matrices became available only much later

2) If an element of the TLS matrix is negative, then the corresponding element of the matrix of subsidies on products should be *at least* as big in absolute value as this TLS figure.

3) Subsidies on *stock accumulation* should be equal to the exogenous (previously estimated) values.

4) Subsidies must be *lower than its base* (the sum of basic prices and trade and transport margins).

These restrictions ensured that the resulting implicit subsidy rates were reasonable (in the range of the observed ones in the prior and below 100%).

After solving the model, a final manual check-up of the implicit tax/subsidy rates ensured the full consistency of the results.

3.2.4. Other taxes on products

The not directly allocated (see the accounting conventions mentioned in section 2) *other indirect taxes* by branches were allocated to the individual *use(r)s* proportionately to the corresponding rows of the Use (or IO) table. The use table at purchasers prices were used here since the purchaser price includes the excise tax itself (which in the case of the excise goods alone usually makes up 2/3 of it)

3.2.5. Import duties

National Accounts only provide total tariff revenues without any breakdown by commodity, industry and users. Therefore, the aggregate figure had to be allocated this amount to products, industries and users. The procedure relied mainly on the so called Market Access Map (MacMap), an online database of custom tariffs and market requirements which is based on information and data provided by national customs, statistics institutions and regional trade secretariats and completed with information coming from the databases of other supporting institutions. More details on MacMap can be found at: http://www.macmap.org/SupportMaterials/Methodology.aspx.

Rueda et al (2016) describe how the MacMap data were used for estimating the import duties by products. Firstly, MacMap and COMTRADE data were used to calculate the revenues by product (CN/HS6 code) and destination of imports. Then, the product dimension was aggregated to CPA 2008-A64 breakdown, and implicit maximum (related to the assumption that all trade is under MFN scheme) and minimum (related to the assumption that all trade is under preferences scheme) tariff rates calculated by CPA code for each country of destination. Subsequently, these tariff rates were applied to the values of each EU Member State's imports from the rest of the world. The same rate was applied across industries and process it in an entropy model limiting the total revenues of Import duties by the figure obtained from National Accounts (higher than the ones resulting from the minimum rate provided by MacMap). As a result, they obtained a first estimation of a matrix of import duties (IDM).

Otherwise, if the split of the TLS tables were available from official statistics[29], then the column vector of import duties by products can be residually computed, as follows[30]:

$$ID_i = TLS_i + SP_i - VAT_i - ET_i - OT_i$$

where the *i* subscript refers to products (i.e. row-totals of the corresponding tax/subsidy matrices). All categories on the right hand side must be available from the official statistics.

In this particular case, the benchmark to National Accounts data can be made by adjusting the initial estimation IDM to the new official row totals ID_i, instead of to the overall matrix total (flat adjustment). In any case, the implicit tariff rate should not exceed some reasonable maximum level.

3.3. Elaborating a matrix-distance minimizing model

After the initial estimation of the different layers of the TLS matrices, they were reconciled with official and available total TLS matrices by a matrix-distance minimizing method. The variables of the model consisted of the different components of the given TLS matrix. With the exception of changes in inventories and change in valuables, all other variables (matrix elements) were assumed to be non-negative. The constraints on the individual matrix elements of the model included the requirements that the estimated TLS layers should match the (usually scarcely) available TLS layers and other data available in official statistics. The adding-up, balancing and inequality constraints of the model served as consistency checks to guarantee that the estimated TLS layers are fully consistent with the available statistics, accounting methods and known tax rules (e.g. the implicit effective VAT rates should be less than the standard rate).

The decomposition model can be split into two parts: the estimation of the matrix of subsidies on products and the reconciliation process. Concretely, in addition to the four subsidy-matrix related constraints outlined in sub-section 3.2.3., the reconciliation process further included the following constraints:

1. For each element of the exogenous TLS matrix (by product and user), the TLS value must be equal to the sum of their components ($tls_{ij} = vat_{ij} + et_{ij} + ot_{ij} + id_{ij} - sp_{ij}$ i.e. the corresponding elements of the VAT, excise taxes, import duties, other taxes on products and (in negative) subsidies on products).

2. The row totals of the estimated *excise tax* matrix must be equal to the exogenously given values (as computed from the TLSs and the TAXUD excise revenue tables after reconciling them).

3. Totals of the matrix of the '*other taxes* on products':

[29] Note that subsidies on products, excise taxes and, in most EU-countries, the 'other taxes on products' are applied only to a few products (therefore most products SP_i, ET_i and OT_i are zero). Therefore, the excise taxes revenues by product are available almost for each MS directly from official statistics. In addition, 15 EU countries submitted the official VAT-matrix to Eurostat.

[30] For some countries (e.g. DK, RO) the duties by products could also be available (although they might include other taxes on imports that are not consistent with the IOT).

3.1. If row-totals (other taxes on products) computed from TLS or found in other statistics[31] were reliable, then the row-totals of the estimated other taxes on products matrix must be equal to the exogenously given values.
3.2. If row-totals (other taxes by products) were *not* available/reliable, then the *overall* total of the estimated other taxes on products matrix must be equal to the exogenously given value (as published in the National accounts or official TLS).

4. Totals of the *import duty* matrix:
   4.1. If row-totals (import duties by products) computed from MacMap, National Accounts and official import matrices or computed residually are reliable, then the *row-totals* of the estimated import duties matrix must be equal to the exogenously given values.
   4.2. If row-totals (import duties by products) are not available/ reliable, then only the *overall* total of the estimated import duties matrix must be equal to the exogenously given values (as published in the National Accounts).

5. Excise taxes, import duties and other taxes on products related to *changes in inventories* must be in principle equal to their prior values (usually there is no VAT on stock accumulation). In turn, they were determined by allocating the corresponding TLS figure strictly to one of these types of taxes (or, if the implicit rate is negative, to subsidies). However, changes were allowed wherever any additional constraint (prescribed row-totals, overall totals or ceilings on the implicit tax rate) made it necessary.

6. Share of *consumption* in total VAT revenue must be less than 120%[32] of the consumption share in total VAT liability (VTTL) shown by CASE (2014).

7. Share of *investment* in total VAT revenue must be greater than 77%[33] of the investments share in total VTTL as shown by CASE (2014).

8. For each element of the VAT matrix the implicit *VAT rate* should not exceed the exogenously given corresponding product-specific VAT rates (and in any case, should not be higher than the standard VAT rate).

I have also been cautious and always assumed reasonable implicit duty rates and other taxes on product rates. Note that for HR, for which MacMap data were not available a 10% ceiling was applied for the implicit duty rates. As far as SK is concerned, for the implicit duty rates such a ceiling was applied which made sure that they can be maximum 3 times the corresponding MacMap duty rates, because when – following the MacMap – we assumed that on energy imports no duty is levied, the national account figure for the total could be reached only by this.

[31] We prefer NTLs to National Accounts since the NTLs give details of all related taxes for each SNA code, which might be needed for the reclassification of some components.
[32] Such degree of tolerance is allowed since I found that the household's consumption VAT share in the official CZ VAT-matrix was 20% higher (i.e. 71%) than in CASE (2014), i.e. 59%.
[33] Such degree of tolerance is allowed since I found that the investment VAT share in the official CZ VAT-matrix was 77% (i.e. 10%) of the figure provided in CASE (2014), i.e. 13%.

Note that the total VAT revenue and the VAT by product were prescribed implicitly (residually) by some of the above constraints.

The objective (or penalty) function to be minimized was a quadratic relative distance. When computing the ratios of the estimated variables and their priors in the objective function, a small value (e.g. 0.1) was added to both, which allows 0 prior-values to turn to positive if necessary.

Since data availability, data quality, accounting methods and the tax system are heterogeneous across the EU Member States, the model had to incorporate country-specific constraints and adjustments in order to make it applicable to each country.

4. Transformation of the TLS to GTAP sector break-down and reconciliation with the transformed IOTs

The TLS tables had to be transformed so as to match the GTAP submission requirements. These required the submission of the domestic and import products related TLS tables in GTAP-sector break-down only but not the TLS layers. However, to be able to estimate the TLS tables in GTAP-sector break-down reliably it was deemed necessary to transform its components (layers) separately and add them up to the transformed TLS tables. The elaborated necessary steps of the process (programmed again in GAMS in the TaxTransCxC.gms file) are be summarized in the following subsections:

4.1. GTAP-profile cleaning of the TLS layers

Since the sector break-down of the IOTs and TLS matrices are rather different from that of the GTAP, the transformation had to include the conversion from the 64 IOT sectors (based on the NACE 2/CPA 2008) to the 57 GTAP sectors. However, at this (dis)aggregation level (usually 2-digits), the correspondence between these IOT sectors and the GTAP sectors is not straightforward since IOT classification is compatible with ISIC Rev.4 and GTAP sectors are more aligned to ISIC Rev.3. While the 'one-to-many' and 'many-to-one' type correspondences could be dealt with by (dis)aggregation, one has to eliminate the '*many-to-many*' type correspondences by a procedure called 'GTAP profile-cleaning' of the IOT sectors. This means the use of an *intermediate classification* (IMC) for which neither the IOT<->IMC nor the IMC<->GTAP mappings contain many-to-many correspondences.

To elaborate such a *mapping* the Eurostat’s RAMON correspondence tables, Narayanan et al (2009) and EPU-NTUA (2013) were used. The necessary data to estimate category-, country- and use(r)-specific transformation coefficient/*share matrices* to disaggregate the elements of the domestic and import ESTAT IOTs and, subsequently, convert them into GTAP IOTs came from available Supply, Use and IOTs, the GTAP9 database, Harmonized System (HS) foreign trade statistics, the Structural Business Statistics and the Agricultural Economic Accounts, and the earlier GTAP databases, among others. The data sources and method of the GTAP profile cleaning of the IOTs are described in more details in Rueda et at (2016).

For the GTAP profile cleaning of the TLS layers (which practically means the reallocation of certain subsectors to others) the *output value-shares* were used. For the import taxes, the Harmonized System (HS) foreign trade statistics-based *import shares* were used assuming that the reallocable components (usually not too great) have the same tax rate as the remaining part of their respective sector (a review of these reallocable subsectors suggest that this is usually the case).

4.2. Transformation of the TLS layers from product by industry to product by product dimension

Since the intermediate demand blocks of the original TLS matrix and its layers and hence their GTAP-profile cleaned and transformed versions were still in commodity by industry classification (hence we may refer to it as the TLS_{use} matrix), they had to be reclassified to the same commodity by commodity dimensions as the commodity by commodity dimension IOTs. In this way, we could compute the relevant implicit tax rates. Note, however, that to be consistent with the commodity by commodity dimension IOTs one has to consider its 'net tax on products' row too (coded as D21x31 in the SNA and in the data file). To bring the column totals closer to the IOT's *D21x31 row* transformed the columns of the TLS_{use} matrix from industries to products. To achieve this, from the Supply tables for each industry I computed its *product mix structure* (i.e. the percentage share of the individual products in its total output value) and by using these shares and applying the *industry technology* assumption (Model B, in Eurostat, 2008) I estimated the intermediate part of the TLS matrices and of their layers in the required commodity by commodity dimension. It may be only the approximation of what may have been done by the JRC CEIL Unit when estimating the missing product by product IO-tables[34]. The same transformation was done with each estimated layers of the TLS_{use} matrix too.

4.3. Estimation of priors for the transformed TLS layers

For the transformation of the GTAP-profile cleaned TLS layers to GTAP branch break-down - similarly to what was done in the GTAP profile cleaning process - the *output value-shares* were used as a default. For the import taxes, the Harmonized System (HS) foreign trade statistics-based *import shares* were used. and could be used for the similar transformation of the domestic and import IOTs. However, in each case – in particular in the case of the alcohol and tobacco-related excise taxes - it was considered how different were the tax/subsidy rates across the components (GTAP-sectors) of the given IOT sectors.

I have modified the transformation coefficients of the Nace 2 import duty matrix so that now block-wise shares are used. Note, that the TLS-transformation model (see in the next subsection) does not change these (coefficients-based) *transformed duty matrices*, therefore it was necessary to harmonise them with the IOT-transformation model estimated import matrix figures (so that the implicit duty rates be reasonable).

I always emphasized that the transformation of the IOTs at basic prices (UF tables) should be done *integrated* with the TLS tables. Otherwise many weird implicit taxes rates show up as

[34] Note, that for Bulgaria (BG) the Supply table was not available either, therefore the JRC CEIL unit must have used a quite different estimating method.

the consequence of that the split of the IOT of the C10-12 coded 'food-beverages-tobacco' sector is done before considering the corresponding TLS figures. For example, for AT 17 of the 22 bln € of the C10-12 sector related TLS value is the excise tax. Therefore, one has to make sure that when splitting the IOT's C10-12 sector related row to GTAP-sectors a correspondingly high share be allocated to the b_t (beverage and tobacco) row, which is the only part liable to excise tax. This shows the importance of separating out the excise tax from the 'other taxes on products. Note, that since the above outlined new, 'integrated' method for estimating the transformed IOTs and TLSs is a little bit more complicated, it may take a little bit longer to process a given country.

Therefore, the JRC CEIL unit's estimates have surely incorporated additional errors (shortcomings) in the tables. Nevertheless, we have used additional constraints as error correction measures to make sure that the resulting implicit tax rates were reasonable enough compared to the one obtained with SUTs and TLS^{USE} tables. A final check of the implicit tax rates ensured the consistency of the results.

4.4. Reconciliation of the transformed TLS layers

After estimating priors for each transformed TLS layers a mathematical programming model was elaborated and applied again which reconciles the transformed TLS layers with the aggregate TLS matrix and other external indirect tax data and which imposes all balance requirements and other constraints (implicit tax rates, proportions, etc.) on the model estimates of the TLS layers in GTAP-sector break-down.

Concretely, the TLS-transformation model essentially[35] contains the following constraints:

1. For certain elements of the estimated matrix of the '*net taxes on products*' the implicit tax rates should be equal to the exogenously prescribed value
2. For some countries and products the row-total of the estimated '*other taxes on products*' matrix must be equal to the exogenously given figure (computed from the NTL or other sources).
3. For each element of the estimated matrix of the '*other taxes on products*' the implicit tax *rates* should be less than 100 %
4. For the sectors to be split from NACE Rev.2 to GTAP break-down (one to many correspondence), the *implicit tax rates of other taxes* on products with respect to the sum of other taxes on products, import duties and excises should be less than 5 times the corresponding (GTAP sectors->Nace 2 correspondence) implicit tax rate of the IOTs but in any case must be less than 200% (of which mostly the excise tax is expected to be the dominant)
5. For the 'split sectors' related-elements of the estimated matrix of subsidies, the implicit *subsidy rates* should be less than 10 % or (if higher) 5 times the corresponding (average) implicit subsidy rate of the IOT, but in any case must be less than 80%.

[35] Due to exemptions, dealing with negative data values and considerations of the tax system the actual formulas is rather complicated technically, but can be seen exactly in the TaxTransCxC.gms GAMS-code of the model.

6. For all elements of the estimated matrix of subsidies on products, the implicit *subsidy rates* should be less than 100 %

7. If the *official subsidy matrix* exists, then each element of its profile-cleaned and product by product transformed version must be equal to the sum of the corresponding elements (at the common aggregation level) of the estimated ('transformed') subsidy matrix (adding up criteria)

8. If the official subsidy matrix does not exist then the sum of the elements of the estimated subsidy matrix must be equal to the *total subsidy* figure of the national accounts (or if the sum of the negative elements of the TLS are greater in absolute value than the national accounts figure, then must be equal to this sum)

9. If the *official VAT-matrix* exists then each element of its profile-cleaned and product by product transformed version must be equal to the sum of the corresponding elements (at the common aggregation level) of the estimated ('transformed') VAT-matrix (adding up criteria)

10. If the official VAT-matrix does not exist then, the *share of consumption in total estimated VAT revenue* must be less than 123.5% of the consumption share in total VAT liability (VTTL) shown by CASE (2014).

11. If the official VAT-matrix does not exist then the *share of consumption in total estimated VAT revenue* must be greater than 70% of the investments share in total VTTL as shown by CASE (2014).

12. If the official VAT-matrix does not exist (or if the official VAT-matrix exists only for sectors to be split), then for each element of the estimated ('transformed') VAT-matrix the *implicit VAT-rate* (approximated by the VAT/(basic price + excise tax + other taxes on products) ratio) must be less than the VAT-rate of the corresponding product.

13. If the official VAT matrix exists then for each final-demand related elements of the estimated ('transformed') VAT-matrix the *implicit VAT-rate* (as defined above) must be less than 2.5 times the corresponding (at the common aggregation level) implicit VAT-rate of the non-transformed VAT-matrix.

14. For certain countries the *export* column of the estimated ('transformed') *VAT-matrix* must be 0 (no VAT is accounted on exports).

15. If the official VAT-matrix does not exist, then the sum of the elements of the estimated VAT-matrix must be equal to the *total VAT* figure of the national accounts (VAT-revenues of the general government and the European Union Institutions are both included)

16. *Block totals* (at the common aggregation level) of the non-transformed (NACE Rev.2) TLS and the estimated TLS (defined as sum of the estimated 'transformed' TLS layers) should be equal

17. The *duty matrix* is the same as its prior or first estimate (which was computed by matrix-algebraic multiplication using the transformation share matrices)

18. The *stock accumulation*-related taxes and subsidies are estimated to be the same as their first estimates (i.e. as computed by matrix-algebraic multiplication)

Note that some of these constraints are designed to handle the data problems. For example, in the import matrix for SE households' consumption of mining products is negative. Exempting this from the non-negativity constraint resulted in weird results in the split of this cell to GTAP-sectors: the small negative amount was "split" to big negative and positive components. Therefore I had to fix the problem by prescribing that none of the components can be more negative than the aggregate figure.

Apart from the cases when with the official VAT and subsidy matrices were available (see points 7. and 9. in the above list), for the individual TLS layers *block-wise* (add-up) consistency criteria (at the common aggregation level) are not built into the TLS 'transformation' model. This is partly because these estimated layers do not have the official commodity by commodity counterpart.

Since apart from the excise taxes and some 'other taxes on products', usually there are no statistical data which are binding for the *row-totals* of the transformed TLS matrix (even less for the layer matrices), therefore there is a sufficient room for maneuvering in distributing the taxes so that the tax rate caps be respected.

In the TLS-transformation model extraordinarily high implicit tax rates could be prevented by applying a cap, but it is rather difficult to tell what value this cap can be given. When the corresponding aggregate implicit tax rate is weird then necessarily some components (disaggregated implicit tax rates) will have at least as high value. One might think of applying certain reasonable (e.g. max. 100 %) caps only if the aggregate tax rate is not too high. However, every further constraint will jeopardise the solvability (feasibility) of the TLS-transformation model and the resulting fit.

The TLS-transformation models are designed so that they *allow zeros to become positive* if necessary due to the balancing criteria (e.g. if total supply has suddenly jumped up, somebody should use them even if the original use was small or zero.). However, the objective function is sensitive to the small ranges, i.e. tends to allow high coefficients in cells with small quantities. In theory, in cases of small amounts some exogenous value could be given. However, it can be done retrospectively too by anybody. If one replaces the small values by whatever else, this should have only negligible effect on the overall balances. In addition, subsequently one can run a rebalancing program to eliminate all such imbalances.

Certainly, I am not in the position neither to find out the proper patterns by which such uncomfortable small figures have to be replaced, nor to tell what this rebalancing program should look like.

The distance-minimizing model may took advantage of the fact that in most cells (one cell representing the use of a given product by a given user) the available 'net tax' figure contains only one or two types of taxes (the other TLS layers are zero), therefore the minimization of the relative distance (objective) function pulls the distributable tax/subsidy amounts to the right cells (position) of the relevant TLS layer matrices, even without being informed about the precise tax mechanisms.

4.5. Split of the TLS layers into domestic and imported uses-related components

Finally, to meet the requirements of the GTAP submission the distance minimizing-model estimated ("transformed") TLS layers had to be split into domestic and imported uses-related components.

For this purpose the following considerations were taken into account:

1. Import duties are rather small and only levied on Ex-EU imports of material products.
2. Other taxes on product (without the excises and the import duties) are also rather little in almost all MSs. From the NTLs, we know what type of taxes are behind these figures, therefore it is not too difficult to find out whether they are related to domestic products only or to the imports or both (note, that in the NTL most MSs also filled in the cells for the "other taxes on imports").
3. Subsidies, which are also relatively small and concentrated to a few products and users, are mostly assumed to apply both the domestic and import products (e.g. in the case of energy products). Indeed, governments may prefer subsidizing only the domestic products, but when the domestic-import composition of the given purchase did not support this hypothesis, I had to discard this idea. For example, in Italy there was a large amount of households' motor vehicle purchase related subsidy (car scrapping premium?), but it exceeded the basic price value of the domestic component of the given expenditure, hence I had to assume that both domestic and import cars were subsidised.
4. As a consequence of the above facts it is feasible to separate the exclusively import- and domestic- products related taxes, while the rest is levied on both (irrespective of their origin, or in modelling terms the composite good is taxed – outstanding examples are the VAT and the excises).

Then those taxes which were assumed to apply on composite goods had to be distributed between import and domestic uses. This could be done in each cell of the given TLS layer-matrix proportionately to the shares of the corresponding domestic and import uses. Although I managed to eliminate or at least minimise the number and magnitude of the slacks (statistical error terms) in the estimates, the remaining slacks are now also split to domestic and import parts in the same way.

Note, that for the standard GTAP-database only the aggregate TLS matrices are needed, the estimated layers may form an auxiliary database for model builders and economic analysts.

5. Overview of the numerical results

Note first of all, that parts of the results are not estimates but rather just the translation of the original Eurostat original data. For these latter, I do take neither credit nor blame, but important efforts have been made to get an explanation for them from the Eurostat/NSIs and correction of them if proved to be necessary.

The results containing big Excel-files are uploaded to the 'incoming' ftp folder created by the JRC/Seville and are located in the internet at the ftp://eugtap-guest:zt0JtxlfX9qx@ftp.jrc.es/incoming/ site.

5.1. Performance of the TLS-decomposition model

For most of the 4 countries with confidential data (IE, LT, PL and SE) the decomposition model found optimal solution only after allowing for not too high - but above the rounding errors justified level - slacks (statistical error terms) in the model. This phenomenon is certainly due to the many mismatches between the location of the taxes and the commodity flows (at least in those sectors where the confidential IOT data were located). However, and despite of the - in this sense - imbalanced priors taken from the decomposition model results, the TLS-transformation program ran surprisingly well.

For many countries (FR, HR, LT, MT, PL, PT, RO, SE, SK and UK), the TAXUD data based excise tax revenue figures (in most of the cases for the C19 refinery products but for SK and the UK also for the C10-12 food-beverage-tobacco products) had to be cut more-less to fit to the lower figure for the corresponding row-total of the gross tax matrix (TLS+Subsidy).

In some cases the model could not allocate enough tax revenue to the VAT. In these cases either in the intermediate demand or the final demand (or in both) the cap was increased on the implicit VAT (rate). In some cases this can be justified not only by this technical necessity but also by referring to the fact that the estimated VAT-base (basic price+excise+other tax) may not make up the true base (which certainly includes the duties, and which may be different from what is in the SUIOTs anyway). Also note that in the VAT matrices, the whole VAT revenue (as reported in the national accounts) is accounted for, although VAT is also collected after the turnover of second-hand property (which does not appear in the current IOT).

As mentioned, negative values showing up at, in principle, non-negative categories like consumption, exports, gross fixed capital formation posed considerable challenges for the decomposition model. For example, I had to circumvent the problem of negative value added tax figures of the official French VAT matrix by introducing a negative component of the VAT (as a parameter in the GAMS code) so that the non-negativity constraint of the VAT variable may be maintained. Then, I also had to "transform" these constraints to GTAP-sectors to be used in the TLS-transformation model.

In addition to the mentioned ones, several further exemptions had to be made because of the original data. These are included in the GAMS code. However, since during the development of the GAMS-code, 6 different versions of the IOTs and the TLS matrices were processed.

5.2. Performance of the TLS-transformation model

Various consistency checks were elaborated to see if the model estimated transformed TLS-layers fit to the (row- or column-) totals derived from official statistics and if the totals of the model estimated TLS-layers add up. Small (less than 10 million euro) overall discrepancy (slack) is usually allowed by the TLS-transformation model to deal with the rounding inconsistencies and the few exceptions from the strict balancing criteria (these exemptions are mostly made when the official statistics based target value is negative but the matching variable is declared to be as non-negative). Discrepancy also appears here if the figures of the official TLS do not add up.

Even in this last minutes I had to discover serious flaws in the data. Thanks to my decision to try to *abolish/minimise the slacks*, in the case of PL, from the location and magnitude of the equations appearing as infeasible it unfolded that in the HS-foreign trade statistics many countries simply *failed to report the natural gas exports and imports in its right place* (under the 271111 or 271112 codes) or at all, so I had to revise the estimates (in many cases computing it residually). Concretely, it seems to affect the LU, NL and SE IOTs, for which I had to re-run the IOT and TLS transforming models.

For checking purposes the *implicit tax rates* were computed. However, these implicit tax rates has to be viewed with proper care at least for 2 reasons: in many cases the denominator (basic price) does not properly represent the tax base and some seemingly extraordinarily high tax rates are just the consequence of a denominator close to zero, which in absolute value do not have any significance. Note, that in this case (of small values) one can just eliminate these weird implicit tax rates by shifting the undesired amounts to other cells either without any counterbalancing changes in other cells, or by the *"rooking" method* of the operations research.

Since in many ('one-to-many') cases the transformation meant the disaggregation of a given figure, if the aggregate figure is too low/high then some of the disaggregated figures will be too low/high too.

Bearing in mind these circumstances and the data problems discussed earlier in this paper, we can say that the TLS-transformation model produced quite good results.

Although the overwhelming majority of the estimates seem absolutely acceptable, I have compiled a list of 329 weird implicit tax rates on the 'composite' tax bases (not separating the domestic and import components).

Note, that the task was to estimate 57*(57+6)*28=100548 elements of the TLS matrices of the EU countries (nothing to say that even their 5 components had to be also estimated which would increase the elements to half million!), therefore the mentioned 329 elements make up only 0,33 % of the total.

For CY, CZ, DE and SI I have not found any significant weird tax rates.

For EE, ES, FR, HR, LU, LV, MT, NL, PL, PT, SK I have found only 3-4 problematic tax rates. Most of them can not be regarded to be 'ridiculous' or clearly out of range, only by considering the likely tax rules and comparing them with 'similar' or 'related' tax rates one may conclude that some further checks/improvements would be needed.

For the UK I found 5 problematic 'composite' tax rates, while for the rest I found at least 9 questionable tax rates. These are, however, mostly related to the apparently not sufficiently proportional split of the agriculture and food industry related taxes and subsidies.

Note, that for most of the 4 countries where the confidential data were replaced by our own estimates (IE, LT, PL and SE) the decomposition (and subsequently the transformation-) model did not work too well due to the many mismatches between the location of the taxes and the commodity flows (at least in those sectors where the confidential IOT data were located).

In any case, I am rather glad to observe that the remaining problems are so few (about 1 % of the *positive* tax rates of the estimated matrices) that we can now compiling easily a full list of them and carry through a one-by-one examination.

Numerical results are shown in the TaxDecOut….xlsx Excel files. As far as the 'comprehensive summary tables' of the results (located in the FZ2767:GG2826 and FZ2831:GG2892 ranges) we can illustrate them by presenting the French summary tables:

Table 2. French tax- and subsidy-rates in the intermediate consumption in 2010, %

GTAP sector name	GTAP sector code	Subsi-dies	Excise taxes	VAT	Other indirect taxes	Import duties	Net taxes total
		FR	FR	FR	FR	FR	FR
Paddy rice	**pdr**	1,6	0,0	0,0	0,0	0,0	**-1,5**
Wheat	**wht**	1,8	0,0	0,1	0,0	0,0	**-1,7**
Cereal grains nec	**gro**	1,7	0,0	0,1	0,0	0,0	**-1,7**
Vegetables fruit nuts	**v_f**	1,2	0,0	0,0	0,0	0,0	**-1,1**
Oil seeds	**osd**	1,2	0,0	0,0	0,0	0,0	**-1,2**
Sugar cane sugar beet	**c_b**	1,7	0,0	0,0	0,0	0,0	**-1,7**
Plant-based fibers	**pfb**	0,1	0,0	0,0	0,0	0,0	**0,0**
Crops nec	**ocr**	1,6	0,0	0,0	0,0	0,0	**-1,6**
Bovine cattle sheep and goats horses	**ctl**	1,8	0,0	0,0	0,0	0,0	**-1,8**
Animal products nec	**oap**	1,8	0,0	0,0	0,0	0,0	**-1,8**
Raw milk	**rmk**	1,8	0,0	0,0	0,0	0,0	**-1,8**
Wool silk-worm cocoons	**wol**	0,1	0,0	0,1	0,0	0,0	**0,0**
Forestry	**frs**	3,3	0,0	0,0	0,0	0,0	**-3,3**
Fishing	**fsh**	0,0	0,0	0,3	0,0	0,1	**0,4**
Coal	**coa**	0,0	0,0	0,1	0,0	0,0	**0,1**
Oil	**oil**	0,0	0,0	0,0	0,0	0,0	**0,0**
Gas	**gas**	0,0	0,5	0,2	0,0	0,0	**0,7**
Minerals nec	**omn**	0,0	0,0	1,1	0,0	0,0	**1,1**
Bovine meat products	**cmt**	0,1	0,0	1,7	0,5	0,0	**2,2**
Meat products nec	**omt**	0,1	0,0	1,6	0,6	0,0	**2,1**

Vegetable oils and fats	**vol**	0,0	0,0	0,8	0,6	0,0	**1,4**
Dairy products	**mil**	0,1	0,0	0,7	0,5	0,0	**1,2**
Processed rice	**pcr**	0,0	0,0	0,4	0,5	0,0	**1,0**
Sugar	**sgr**	0,1	0,0	1,1	0,4	0,0	**1,5**
Food products nec	**ofd**	0,0	0,0	1,3	0,7	0,0	**2,0**
Beverages and tobacco products	**b_t**	0,0	24,2	1,4	0,8	0,0	**26,5**
Textiles	**tex**	0,0	0,0	1,1	0,0	0,8	**1,9**
Wearing apparel	**wap**	0,0	0,0	4,2	0,0	1,8	**6,1**
Leather products	**lea**	0,0	0,0	1,0	0,0	1,8	**2,8**
Wood products	**lum**	0,0	0,0	0,4	0,0	0,1	**0,6**
Paper products publishing	**ppp**	0,2	0,0	3,0	0,6	0,0	**3,4**
Petroleum coal products	**p_c**	0,0	38,9	5,1	0,0	0,0	**44,0**
Chemical rubber plastic products	**crp**	0,0	0,0	0,9	0,3	0,1	**1,4**
Mineral products nec	**nmm**	0,0	0,0	0,9	0,0	0,2	**1,1**
Ferrous metals	**i_s**	0,0	0,0	0,1	0,0	0,1	**0,1**
Metals nec	**nfm**	0,0	0,0	0,1	0,0	0,1	**0,2**
Metal products	**fmp**	0,0	0,0	0,6	0,0	0,1	**0,7**
Motor vehicles and parts	**mvh**	0,0	0,0	2,5	0,7	0,1	**3,4**
Transport equipment nec	**otn**	0,0	0,0	2,6	0,0	0,0	**2,6**
Electronic equipment	**ele**	0,0	0,0	1,4	0,0	0,3	**1,6**
Machinery and equipment nec	**ome**	0,0	0,0	1,5	0,0	0,3	**1,8**
Manufactures nec	**omf**	0,0	0,0	7,5	4,4	0,5	**12,4**
Electricity	**ely**	0,5	0,0	1,7	2,1	0,0	**3,4**
Gas manufacture distribution	**gdt**	0,6	0,0	0,6	2,2	0,0	**2,2**
Water	**wtr**	1,1	0,0	2,8	3,9	0,0	**5,6**
Construction	**cns**	0,0	0,0	2,7	0,5	0,0	**3,2**
Trade	**trd**	0,0	0,0	0,6	0,0	0,0	**0,6**
Transport nec	**otp**	4,9	0,0	0,8	1,4	0,0	**-2,7**
Water transport	**wtp**	9,5	0,0	0,0	3,8	0,0	**-5,7**
Air transport	**atp**	0,0	0,0	0,4	3,1	0,0	**3,4**
Communication	**cmn**	0,3	0,0	2,9	0,3	0,0	**2,9**
Financial services nec	**ofi**	0,0	0,0	3,1	0,0	0,0	**3,1**
Insurance	**isr**	0,0	0,0	0,0	17,0	0,0	**17,0**
Business services nec	**obs**	0,1	0,0	2,7	1,5	0,0	**4,1**
Recreational and other services	**ros**	0,2	0,0	2,4	1,3	0,0	**3,5**
Public Administration Defense Education Health	**osg**	0,0	0,0	1,5	1,2	0,0	**2,7**
Dwellings	**dwe**	0,0	0,0	0,0	0,0	0,0	**0,0**
	Total	**0,5**	**0,9**	**1,9**	**0,9**	**0,0**	**3,2**

Table 3. French tax- and subsidy-rates in the household consumption in 2010, %

GTAP sector name	GTAP sector code	Subsi-dies	Excise taxes	VAT	Other indirect taxes	Import duties	Net taxes total
		FR	FR	FR	FR	FR	FR
Paddy rice	**pdr**	0,0	0,0	0,0	0,0	0,0	**0,0**
Wheat	**wht**	5,2	0,0	11,5	0,0	0,0	**6,3**

Cereal grains nec	**gro**	4,9	0,0	11,5	0,0	0,0	**6,6**
Vegetables fruit nuts	**v_f**	2,6	0,0	11,5	0,0	0,0	**8,8**
Oil seeds	**osd**	4,4	0,0	11,5	0,0	0,0	**7,0**
Sugar cane sugar beet	**c_b**	5,4	0,0	11,5	0,0	0,0	**6,1**
Plant-based fibers	**pfb**	0,3	0,0	11,5	0,0	0,0	**11,1**
Crops nec	**ocr**	4,6	0,0	11,5	0,0	0,0	**6,9**
Bovine cattle sheep and goats horses	**ctl**	4,8	0,0	11,5	0,0	0,0	**6,7**
Animal products nec	**oap**	5,1	0,0	11,5	0,0	0,0	**6,3**
Raw milk	**rmk**	5,4	0,0	11,5	0,0	0,0	**6,1**
Wool silk-worm cocoons	**wol**	0,0	0,0	11,5	0,0	0,0	**11,5**
Forestry	**frs**	3,0	0,0	3,7	0,0	0,0	**0,7**
Fishing	**fsh**	0,0	0,0	15,2	0,0	0,2	**15,4**
Coal	**coa**	0,0	0,0	0,0	0,0	0,0	**0,0**
Oil	**oil**	49,7	0,0	38,2	0,0	0,0	**-11,5**
Gas	**gas**	100,0	424,2	0,0	0,0	0,0	**324,2**
Minerals nec	**omn**	2,8	0,0	38,2	0,0	0,0	**35,4**
Bovine meat products	**cmt**	0,1	0,0	12,6	0,3	0,0	**12,8**
Meat products nec	**omt**	0,1	0,0	12,6	0,3	0,0	**12,8**
Vegetable oils and fats	**vol**	0,1	0,0	12,6	0,5	0,0	**13,1**
Dairy products	**mil**	0,1	0,0	12,6	0,3	0,0	**12,7**
Processed rice	**pcr**	0,0	0,0	12,6	0,5	0,0	**13,1**
Sugar	**sgr**	0,1	0,0	12,6	0,5	0,0	**13,0**
Food products nec	**ofd**	0,1	0,0	12,6	0,0	0,0	**12,5**
Beverages and tobacco products	**b_t**	0,1	79,9	12,6	0,2	0,0	**92,6**
Textiles	**tex**	0,0	0,0	50,9	0,0	1,7	**52,6**
Wearing apparel	**wap**	0,0	0,0	50,9	0,0	4,3	**55,2**
Leather products	**lea**	0,0	0,0	50,9	0,0	4,9	**55,8**
Wood products	**lum**	0,0	0,0	24,6	0,0	0,3	**24,9**
Paper products publishing	**ppp**	0,2	0,0	14,4	0,8	0,0	**14,9**
Petroleum coal products	**p_c**	0,0	46,3	29,2	0,0	0,0	**75,5**
Chemical rubber plastic products	**crp**	0,0	0,0	34,1	2,2	0,2	**36,4**
Mineral products nec	**nmm**	0,0	0,0	22,7	0,0	0,3	**23,0**
Ferrous metals	**i_s**	0,0	0,0	11,1	0,0	0,0	**11,1**
Metals nec	**nfm**	0,0	0,0	11,1	0,0	0,0	**11,1**
Metal products	**fmp**	0,0	0,0	23,8	0,0	0,3	**24,1**
Motor vehicles and parts	**mvh**	0,0	0,0	23,8	1,0	0,5	**25,3**
Transport equipment nec	**otn**	0,0	0,0	28,7	0,0	1,3	**30,0**
Electronic equipment	**ele**	0,0	0,0	23,1	0,0	1,1	**24,2**
Machinery and equipment nec	**ome**	0,0	0,0	43,8	0,1	0,8	**44,7**
Manufactures nec	**omf**	0,0	0,0	30,6	2,0	1,0	**33,6**
Electricity	**ely**	0,0	0,0	17,6	1,7	0,0	**19,3**
Gas manufacture distribution	**gdt**	0,0	0,0	17,6	1,7	0,0	**19,3**
Water	**wtr**	0,0	0,0	4,8	2,9	0,0	**7,7**
Construction	**cns**	0,0	0,0	9,8	0,6	0,0	**10,4**
Trade	**trd**	0,1	0,0	1,8	0,0	0,0	**1,7**
Transport nec	**otp**	18,5	0,0	6,9	4,4	0,0	**-7,2**
Water transport	**wtp**	6,4	0,0	1,8	0,0	0,0	**-4,6**
Air transport	**atp**	0,0	0,0	1,1	3,2	0,0	**4,3**

Communication	**cmn**	0,1	0,0	15,5	0,4	0,0	**15,8**
Financial services nec	**ofi**	0,0	0,0	2,2	0,0	0,0	**2,2**
Insurance	**isr**	0,0	0,0	0,0	17,0	0,0	**17,0**
Business services nec	**obs**	1,0	0,0	2,1	3,3	0,0	**4,4**
Recreational and other services	**ros**	2,9	0,0	5,0	13,2	0,0	**15,4**
Public Administration Defense Education Health	**osg**	0,0	0,0	2,4	0,5	0,0	**2,9**
Dwellings	**dwe**	0,0	0,0	0,0	0,0	0,0	**0,0**
	Total	**0,8**	**2,4**	**8,0**	**1,8**	**0,1**	**11,5**

France was selected because it is not only a big economy and the largest country in the EU, but mainly because its economic structure is more representative than that of the other big EU countries: mining, agriculture, manufacturing industry and many services (e.g. tourism) are quite significant.

Based on the above tables we say the following:

Almost all of the household consumption related implicit tax rates seem to be reasonable. High implicit VAT rates (in France the standard VAT rate was 19.6%) are the consequence of the fact that for some products a high overall tax rate was reported in the TLS^{use} and IOTs, but only little could be accounted as non-VAT type of taxes. Therefore, too much remained for VAT. In the case of household consumption of natural gas and crude oil products (and to less extent of other mining- and energy-products), the weird rates are the consequence of the very small amounts are concerned. In this case, when the aggregate IOT and TLS figures had to be disaggregated, the applied (distribution) shares were not necessarily computed consistently with each other: if one of them (e.g. practically the tax base) was even lower than a threshold, then the (distribution-) shares were not computed from the corresponding figures of the GTAP9.1. database, but rather from some more aggregated categories.

The intermediate consumption related implicit tax rates seem to be quite reasonable. Clearly, these rates are only the average rates computed from the figures of all intermediate users (sectors) of the given product.

The above tables show clearly the following:

- The import duties are allocated mostly to the clothing articles
- VAT is allocated mostly to the household consumption
- Excise taxes are allocated mostly to the household consumption
- Subsidies are also allocated mostly to the household consumption

These are what one would expect. Therefore, we can conclude that the estimated TLS layers for France are acceptable.

In general, the decomposition of the household consumption - and (total) intermediate consumption - related implicit net tax rates respectively present weird rates that are mostly due to the very small denominator (commodity flow), the original Eurostat data (either left aggregated or the aggregate odd figure is split to similarly odd GTAP-sector components). However, there are/may be still some case when the TLS-transformation model has certain shortcomings (e.g. in disaggregating negative figures to big positive and big negative components or not adequately setting the caps for the various tax/subsidy types).

Note, that in terms of implicit tax rates, the results for the intermediate consumption (all user branches together) show greater diversity (as opposed to uniformity) across products, which is due its aggregated nature.

6. Summary

Despite of the unexpected problems of the data eventually I could produce reasonable result for each EU MSs. After receiving feedbacks from experts and studying carefully the results, I am sure that the current version of the results could be built into the GTAP database.

In summary, the results can be regarded to be quite novel and hopefully encouraging for other researchers (e.g. outside the EU) to apply this or similar method to estimate TLS-layers. A more direct benefit of the exercise was that during the accomplishment of the tasks, I acquired a better understanding of the country-specific tax mechanisms and accounting practices, which may be extremely useful in the future revision/extension of the TLS estimates. Also in the process I developed a transparent, reproducible method (well-commented and maximally generalised GAMS-codes) which is as automated as possible (mainly using the GAMS GDXXRW facility and GAMS-Excel interface to read in the data and report the results).

To solve the novel task of TLS-decomposition I had to apply and combine the available matrix adjustment models and techniques (epsilon-trick to allow for more positive elements in the estimated matrix, allowing small slacks) in a rather creative way, occasionally developing new techniques (e.g. adding the inverse of the relative errors to the 'normalized squared difference'-like objective function of the decomposition and transformation models) and estimating as good priors as possible (so that the results do not depend very much on the choice of the objective function).

Elaborating the transformation matrices from the IOT sectors to the GTAP-sectors helped to clarify the NACE Rev.2–GTAP sectors correspondence (e.g. fodder maize), which the GTAP-experts also welcomed as a good basis for the needed revision of the GTAP sector definitions so that they be compatible with the new NACE Rev.2/ISIC Rev.4 classifications.

As a side-product of the work, I have created a comprehensive auxiliary database (by integrating the SBS, Agricultural Economic Accounts, National Accounts, NTL, HS-Foreign Trade, MacMap, TAXUD excise data) which may serve for various further projects and models too.

The comprehensive database, in particular the estimated IOTs and TLS layers in GTAP format can be used for the calibration of such a tax- and price-policy oriented multiregional computable general equilibrium (CGE-) model which intends to assess the effects of tax base- and tax rate changes on the production costs, prices, government budget, real income of the various household groups and relative price driven changes in the demand patterns. Naturally, such model building would require the cooperation of the interested researchers and institutions.

7. References

AMECO database (DG ECFIN, European Commission) 2010 exchange rates against the Euro [13. Monetary variables].

Bacharach, M. (1970) *Biproportional Matrices and Input–Output Change* (Cambridge, UK, Cambridge University Press).

Britz and Witzke (2012), "CAPRI model documentation: 2014", database of the "Common Agricultural Policy Regional Impact" modelling system (CAPRI) at Member State level

CASE (2013) 'Study to quantify and analyse the VAT Gap in the EU-27 Member States - Final Report' - report commissioned by the EC (DG TAXUD). Center for Social and Economic Research, Warsaw, (TAXUD/2012/DE/316, FWC No. TAXUD/2010/CC/104 EC VAT-gap).

CASE (2014) '2012 Update Report to the Study to quantify and analyse the VAT Gap in the EU-27 Member States' - report commissioned by the EC (DG TAXUD). Center for Social and Economic Research, Warsaw (TAXUD/2013/DE/321, FWC No. TAXUD/2010/CC/104 EC VAT-gap).

EPU-NTUA (2013) Assessment of Policy Impacts on Sustainability in Europe - Baseline and exploratory scenarios, parameters and validation, Deliverable no.: D 4.1, Grant Agreement no.: 283121, Project Acronym: APRAISE, Theme: ENV.2011.4.2.1-1: Efficiency Assessment of Environmental Policy Tools Related to Sustainability.

European Commission (2004) TAXATION PAPERS – 'VAT indicators' - working paper (No. 2/2004, DOC TAXUD/2004/2004–EN) – publication of the EC (DG TAXUD).

European Commission (2009) "Study to quantify and analyse the VAT gap in the EU-25 Member States", Report by Reckon LLP submitted to the DG Taxation and Customs Union.

European Commission (2012a) Excise Duty Tables – Tax receipts (Energy products and Electricity, Alcoholic beverages, Tobacco) – publication of the EC (DG TAXUD) Ref 1.035.

European Commission (2012b) Excise Duty Tables – Part II – Energy products and Electricity – publication of the EC (DG TAXUD) in January 2010, Ref 1.030.

European Commission (2012c) 'VAT Rates Applied in the Member States of the European Community – Situation at 1st July 2010' - Taxud.c.1(2010)477911 – EN publication of the EC (DG TAXUD).

European Commission (2014) Detailed list of taxes and social contributions according to national classification NTLs – downloadable from EC (DG TAXUD).

Eurostat database:

- National Accounts 2010-2012 non-financial accounts [nasa_nf_tr]
- Consumption expenditure by COICOP-categories [nama_co3_c]
- Investment by institutional sectors [nasa_nf_tr]
- Main national accounts tax aggregates [gov_a_tax_ag]

Eurostat (2008) European Manual of Supply, Use and Input–Output Tables. Methodologies and Working Papers. Luxembourg, Office for Official Publications of the European Communities.

Eurostat (2013) *European system of accounts 2010 —ESA10.* Luxembourg, Office for Official Publications of the European Communities.

Eurostat (2014), *Manual on the changes between ESA 95 and ESA 2010.* Luxembourg, Office for Official Publications of the European Communities.

Huff, K., McDougall, R. and Walmsley, T. (2000), "Contributing Input-Output Tables to the GTAP Data Base", GTAP Technical Paper, No.1. Release 4.2

ITC: International Trade Center (2016) MacMap database and methodology.

Matrix Insight Ltd (2013) "Economic analysis of the EU market of tobacco, nicotine and relatedproducts" - *Revised Final Report for the Executive Agency for Health and Consumers*(Specific Request EAHC/2011/Health/11 for under EAHC/2010/Health/01 Lot 2).

Miller. R.E. and Blair, P.D. (2009) *Input-Output Analysis. Foundations and Extensions*. (New York, USA, Cambridge University Press).

Müller, M., Pérez-Dominguez, I., Gay, S. H. (2009) *Construction of Social Accounting Matrices for EU27 with a Disaggregated Agricultural Sector (AgroSAM),* EUR 24010 EN, JRC Scientific and Technical Reports, Luxembourg, Office for Official Publications of the European Communities.

Narayanan G., B.; Dimaranan, B.V. and McDougall, R.A. (2009) Chapter 2: Guide to the GTAP Data Base Center for Global Trade Analysis, Purdue University.

OECD (2014) Producer and Consumer Support Estimates database (European Union) http://www.oecd.org/tad/agricultural-policies/producerandconsumersupportestimatesdatabase.htm

OECD (2015) Environmentally Related Taxes, Fees and Charges - Revenues raised by environmentally related taxes for selected countries. OECD Database on instruments used for environmental policy

Révész, T. (2013) Comparison of GTAP and Eurostat data, EC JRC manuscript.

Révész, T. (2014) Decomposing the 2010 Eurostat product tax matrices - The case of Hungary, EC JRC manuscript.

Revesz, T. (2016) Decomposition of the ESA2010 Eurostat net tax matrices and the transformation to GTAP format - paper presented at the 19th Annual Conference on Global Economic Analysis, held June 15-17, 2016 in the The World Bank, Washington DC, USA

Rueda-Cantuche, J.M., Beutel, J., Remond-Tiedrez, I. and Amores, A. F. (2015) "Good Practice Guidelines in the Estimation of National Use Tables at Basic Prices and Valuation Matrices: An Illustration with European Countries", Economic Systems Research, *under revision*.

Rueda-Cantuche, J. M. - Revesz, T. - Amores, A. F. - Velázquez, A. - Mraz, M. - Ferrari, E. - Mainar, A. - Montinari, L. - Saveyn, B. (2016) : Improving the European Input-Output Database for Global Trade Analysis (EU-GTAP) - EU-GTAP Project Final report June 30, 2016, delivered by the European Commission JRC to the Directorate General for Trade (JRC Nº33705-2014-11 and DG TRADE 2014/G2/G10)

Schneider, F. (2010), "The Shadow Economy in Europe, 2010", Johannes Kepler University of Linz, report sponsored by A.T. Kearney Co. and VISA Europe. http://media.hotnews.ro/media_server1/document-2011-05-8-8602544-0-shadow.pdf

United Nations (2016), "*UN Handbook of Supply, Use and Input-Output Tables with Extensions and Applications*", New York, forthcoming.

WTO-ITC (2007) World Tariff Profiles – 2006. World Trade Organization (WTO) and International Trade Centre (UNCTAD/WTO). Geneva.

Content