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The Figaro project: The EU inter-country supply, use and input-output tables

Prepared by Eurostat[1]

Summary

This document describes the joint project between Eurostat and the European Commission's DG Joint Research Centre, which aims to establish an annual production of EU Inter-country Input-Output Tables and a five-yearly production of EU Inter-country Supply, Use and Input-Output Tables (EU-ICSUIOTs). The EU-ICSUIOTs constitute a further development of the current regularly published EU and Euro area consolidated SUIOTs. The EU-ICSUIOTs will serve to support the analyses of the economic, social and environmental consequences of globalisation in the EU by means of studies on competitiveness, growth, productivity, employment and international trade (e.g. global value chains). It shall be complemented with (i) a regular combination of micro and macro data sources to construct the EU-ICSUIOTs; (ii) careful checking of user needs of various European Commission's DGs for policy analyses, and (iii) an institutional perspective by setting up consistent EU-ICSUIOTs, recognised by international agencies such as OECD, WTO and UN, and used as such in a Global Inter-country Supply, Use and Input-Output framework.

The project started in October 2015 and we will summarise here the current state of play providing information on the project, a review of the methods to construct global supply, use and input-output tables and the methodology currently being discussed within the project team and with the OECD.

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I. Background

1. Over the last decade, the scientific community has been working on the construction of several multi-regional input-output (MRIO) databases. The main aim of the work has varied from environmental applications (e.g. footprints) to socio-economic applications (e.g. global value chains). The development of multiple databases alongside each other has given researchers the opportunity to compare their approaches. Methodologies, and their underlying assumptions, differ among the databases, and so do the results. Convergence of these methods is now called for, and Eurostat, together with the European Commission's Joint Research Centre (JRC), has taken up the challenge to develop a statistical standard recognised by international organisations such as the OECD, UN and WTO. The acronym of the project is FIGARO, meaning *Full International and Global Accounts for Research in Input-Output Analysis* and it has started in October 2015 and will be finished in December 2017.

2. This project fits in the medium term strategy for National Accounts in the context of the European statistical programme for the period from 2013 to 2017 regarding the following headings: (1.3) Economic globalisation with the enhanced measurement of globalised production; analysis of global value chains, through appropriate input-output tables and global business statistics; (2.1) Economic and social performance with the implementation of ESA 2010 and the database for growth and productivity measurement; and (2.2) Environmental sustainability as the European Supply, Use and Input-Output Tables are an input for input-output modelling with environmental accounts, contributing therefore to the implementation of the political guidelines of the Commission regarding climate change.

3. The Regulation (EU) No 549/2013 of the European Parliament and of the Council of 21 May 2013 on the European System of National and Regional Accounts (ESA2010) in the European Union determines the underlying methodology of the EU-IC-SUIOTs.

4. The FIGARO project aims to produce an experimental EU-Inter Country Supply, Use and Input-Output Tables by summer 2017 for the reference year 2010 in the ESA 2010 methodology. From the experience gained in the project, a work plan will be developed concerning the yearly production of EU-IC-SUIOTs and the production of a time series of EU-IC-SUIOTs from 2010 to 2015 (IOTs 2010-2015, SUTs 2010 and 2015). The EU-IC-SUIOTs constitute a further development of the current regularly published EU and Euro area consolidated SUIOTs.

5. The EU-IC-SUIOTs will serve to support the analyses of the economic, social and environmental consequences of globalisation in the EU by means of studies on competitiveness, growth, productivity, employment, environmental footprints and international trade (e.g. global value chains).

6. This project will rely on the re-use of available data in Eurostat and it is based on the latest relevant methodological framework of the ESA 2010, thus ensuring quality assurance of the published data. The project output – the EU-IC-SUIOTs - will serve to evaluate European Union policies and to assess the position of the European Union and the Euro Area in the world. The FIGARO project should create the conditions for sustainable data availability of EU-IC-SUIOTs on a continuous basis to guarantee the provision of data for European policies in the long-term.

7. The development of the EU-IC-SUIOTs will be based on:

(a) A regular combination of global business statistics and macro-economic data sources (e.g. trade statistics, trade by enterprise characteristics, business statistics, National Accounts…) to construct the EU-IC-SUIOTs;

(b) A careful check of user needs of various European Commission's Directorate-Generals (DGs) for policy analyses, i.e.: DG ESTAT, DG ECFIN, DG TRADE, DG ENV , DG RTD , DG EMPL , DG GROW , among other European institutions such as the ECB;

(c) An institutional perspective by setting up consistent EU-IC-SUIOTs, recognised by international agencies such as OECD , WTO and UN , and used as such in a Global Inter-country Supply, Use and Input-Output framework. National compilers of the EU Member States should also be involved in order to ensure that they can take ownership of the national data used in the construction of the EU-IC-SUIOTs.

II. Scope and objectives

8. The scope and objectives of the project are:

(a) To take stock of all current international projects related to the construction of inter country SUIOTs and of user needs of various European Commission's DGs for policy analyses;

(b) To define a suitable methodological framework for the regular production of EU-IC-SUIOTs, including the analysis and treatment of specific issues producing inconsistencies or asymmetries in trade statistics and overall balance procedure;

(c) To construct EU-IC-SUIOTs at basic prices for the reference year 2010 based on SNA2008/ESA2010 methodology and the NACE Rev.2/CPA 2008/ISIC Rev. 4 classifications;

(d) To integrate the EU-IC-SUIOTs into Global (World) Supply, Use and Input-Output Tables, in collaboration with the OECD and UN;

(e) To include a reduced version of the EU-IC-SUIOTs at the A10 sector classification with linked capital and labour productivity indicators;

(f) To integrate the EU-IC-SUIOTs with environmental accounts (in particular, air emission accounts, material flow accounts and energy accounts);

(g) To explore possible extensions of the EU-IC-SUIOTs with global business statistics taking into account the recommendations of the OECD Expert Group of Extended Supply and Use Tables;

(h) To propose a strategy for a regular production of Eurostat's annual EU-MC-IOTs and five-yearly EU-IC-SUIOTs, linked to labour and environmental accounts and possibly with an extended SUIOT format using global business statistics.

9. The EU-IC-SUIOTs aim to be the reference for national and international agencies in terms of analysis of trade, globalisation, socio-economic, National Accounts and environmental policies.

10. The first EU-IC-SUIOT compiled under the FIGARO Project (base year 2010) will be expected to be presented to the NAWG (National Accounts Working Group), the DMES (Directors of Macroeconomic Statistics) and the BSDG (Business Statistics Directors Group) as well to international instances (OECD and UN) and the academic community (e.g. International Input-Output Association Conference) during 2017.

11. At this stage, most of the work has been done to complete objectives 1 and 2. Section 3 describes the main features and organization of the project. Section 4 reviews the methods used so far for the construction of global ICIO tables and Section 5 makes a

methodological proposal for the construction of the EU-IC-SUIOTs. Section 6 concludes with a view to the next steps of the project.

III. Testing Methodology

12. The FIGARO is a project based on National accounts framework. It will build up on available data from the National accounts domain (national SUIOTs) and trade statistics (International trade service statistics and international trade in goods statistics). Business statistics, labour and capital productivity statistics and environmental accounts are part of the project as well, considered for extensions to the European IC-SUIOTs.

13. The EU-IC-SUIOTs will use the latest classifications in terms of activity and products applied on EU currently: NACE Rev 2 (ISIC 4) and CPC/CPA.The scope of the tables are European Member States (28) plus USA to capitalise on work already undertaken by Eurostat in the last years to provide US data within the same classifications as the European SUIOTs.

14. The EU-IC-SUIOTs are meant to be further integrated into the OECD ICIO global database at first and into any other recognised world database built up by international organisations.

15. The FIGARO project will establish the framework, infrastructure and capacity for a regular compilation and dissemination of EU-IC-SUIOTs: annually Eurostat will produce EU-IC-IOTs and an EU-IC-SUT on a five-yearly basis. Every 5 years due to the extensive availability of national data (i.e. use tables at basic prices and its split between domestic and imports, plus the Input-Output Tables) the EU-IC-SUIOTs will serve as a benchmark for the years in between. The benchmark years will be those ending in 0 and 5.

16. The experimental EU-IC-SUIOTs compiled within the FIGARO project will provide an industry breakdown of at least 10 activities, being the ultimate goal to be in line with the 64 activities breakdown available at national level. The project shall provide optimum ways for Eurostat to compile soon after the end of the project EU-IC-SUIOTs for the years in between 2010 and 2015 (depending on availability).

17. The project implementation is divided into eleven work packages with one leading partner each (see the list in Table 1). As of mid-April 2016, the first and second work-packages are complete and in the last phase of reporting. Regarding the work related to trade asymmetries (WP3), it has already started.

Table 1
List of work packages and leading partners

WP	Leading partner
1. Inception, format of EU IC Tables	ESTAT (C)
2. Review methodologies	JRC
3. Treatment of asymmetries in trade statistics	ESTAT (G)
4. Construction EU IC SUT	JRC
5. Construction EU IC IOT	JRC
6. Integration with global ICIOTs	ESTAT (C)
7.Link to capital and labour inputs	JRC
8. Environmental accounts	ESTAT (E)
9. Extended format EU ICIOT	ESTAT (C)
10. Analysis, future	JRC
11. Technical developments	ESTAT (C)
Global business statistics	ESTAT (G)
Sectoral and regional statistics	ESTAT (E)
National Accounts; prices and key indicators	ESTAT (C)
Joint Research Centre	JRC

18. Dealing with trade data will capitalise as well on TEC data (Trade by Enterprise Characteristics) disseminated on the Eurostat web-site and STEC data (Services Trade by Enterprise Characteristics), available from a project run by Eurostat in collaboration with eight countries (AT, CZ, DK, EE, IE, LU, NL and PL).

IV. Review of methods for the construction of global SUIOTs

19. Applications of multi-country input-output tables have surged in the previous 5-10 years or so in various fields of economics like value added trade, production sharing and its implications on employment and growth and environmental issues like CO2 and emissions footprints and resource use, for example. Such research has been spurred by the increasing availability of multi-country input-output tables (MC-IOTs) being made available from various efforts like WIOD, OECD-WTO TiVA initiative, EORA, EXIOBASE, and others. It is therefore highly desired to assure further updates and improvements of such data which form the basis of a growing field of research and allow for a broad range of potential applications in many policy-relevant areas.

20. The recent construction efforts of such databases have however revealed some weaknesses with respect to (i) the availability of data and information needed for constructing these tables, (ii) revealed issues of inconsistencies within and across datasets and resulted in (iii) a variety of methods to address issues like re-exports, constructing valuation matrices, international trade and transport margins, construction of import use tables and estimates of rest-of-world, among others.

21. However, those efforts are being adapted to recent developments in data availability and changes in methodologies, e.g. with respect to changes in industry classification, changes in the method of national accounts (i.e. the change from SNA1993/ESA1995 to SNA2008/ESA2010), provision of additional information like valuation matrices and use tables in basic prices, import use and import input-output tables, changes in trade data (e.g. particularly in services trade as e.g. the change to BPM6), etc. Furthermore, practitioners would be in need of even further details such that these efforts should be undertaken with an eye to be set up in a way to be easily integrated with further statistics (e.g. business statistics, household income statistics, etc.) and other ongoing initiatives (from OECD or Eurostat).

22. This review of methods found similarities and differences concerning the construction of the resulting global IC-SUIOTs with respect to data sources, balancing and reconciliation issues, methodological choices in the various compilations steps, etc. A summary description follows below.

1. Overview

23. Over the last couple of years several global multi country input-output databases have been developed by the scientific community and/or international organisations which are listed below in alphabetical order:

- EORA (University of Sydney, Australia): http://worldmrio.com/
- EXIOBASE (TNO, Netherlands): http://www.exiobase.eu/
- GTAP-MRIO (CICERO) [based on GTAP (Purdue University, US)] https://www.gtap.agecon.purdue.edu/
- OECD/WTO: http://www.oecd.org/trade/input-outputtables.htm

- WIOD (University of Groningen, Netherlands): http://www.wiod.org/new_site/home.htm

24. These databases (for a broad overview of coverage see Table A.1 in the Annex) have been set up with different aims like research on environmental issues (e.g. EXIOBASE, EORA), trade policy measures and impacts (GTAP) and more recently with a focus on accounting for various impacts of value added trade and production integration (OECD-WTO TiVA, WIOD). Other tables (such as those of IDE-JETRO and YNU-GIO) are multi-country tables but do not have a full global scope or are focused on the assessment of material flows (GRAM database), which therefore are less relevant for the construction issues discussed here.

2. Dimensionalities

25. The first obvious characterisation of the various databases is the dimensionalities with respect to countries and industries (or commodities) which are finally provided in the various MC-IOTs, though in the course of the construction process sometimes more industries or commodities are sometimes used. Table A.2 (see Annex) provides this basis information.

26. Concerning the number of countries two databases – EORA and GTAP-MRIO - cover more or less all countries in the world (though in the case of GTAP-MRIO some of the smaller countries are grouped into several broader regions), other data – EXIOBASE, OECD-WTO and WIOD - focus on a group of economies mostly determined by data availability of SUTs and IOTs. In these cases the number of countries covered range from 40 countries as in the WIOD, 43 countries in EXIOBASE and 62 countries covered in the latest release of OECD-WTO; in the latter case China and Mexico are split to better account for processing trade. In all these cases an endogenous rest-of-world (RoW) category is estimated capturing the remaining part of the world as a single entity. In all these databases the EU Member States are included. The IDE-JETRO database covers 10 endogenous countries but split exports and imports as exogenous demand components to 4 regions.

27. Regarding the number of industries, it varies from 129 industries in the EXIOBASE database to 25 industries in the EORA (though a version with much more details – though different across countries – is generally available). Also, the IDE-JETRO database with 76 industries is rather detailed. The GTAP-MRIO provides 57 industries of which 20 are agricultural industries. Finally, the WIOD and OECD-WTO databases provide 35 and 34 industries, respectively. All of these industry classifications (with the exception of GTAP-MRIO) correspond to the ISIC Rev. 3/NACE Rev. 1 classification.

28. Regarding time dimensions, only two datasets so far provide a full time series of MC-IOTs: the EORA covers period 1990-2011/2012 (though based on information mostly on year 2000) and the WIOD provides data over the period 1995-2011 (which is now being updated up to 2014); the starting point 1995 has been chosen due to availability of data of the EU-CEE countries (and Cyprus and Malta) and provision of IOTs and SUTs and national accounts data according to ESA1995. Differently to EORA this time series is based on yearly information (to the extent available) of SUTs. The OECD-WTO effort achieved to provide tables for the series of years 2008-2011 together with MC IOTs for the benchmark years 1995, 2000, and 2005. The IDE-JETRO data are providing data back to 1975 but report data only every 5 years in the recent versions. Finally, GTAP-MRIO and EXIOBASE provide data only for a few years which are years 2000 and 2007 in the case of EXIOBASE and data for base year 2004 and 2007 (but also for selected years from 1990 on) for GTAP-MRIO.

3. Data sources

29. As shown in Table A.3 (see Annex) all but one of the data considered rely on information from SUTs and/or IOTs. This exception is the GTAP-MRIO which is based on a consistent trade data set to which (total) IOTs and SNA data are benchmarked. The IDE-JETRO dataset exclusively is based on input-output data whereas the MC-IOTs provided by EXIOBASE, OECD-WTO and WIOD are mostly based on supply and use tables. In some cases SUTs are derived from existing IOTs using specific assumptions. EORA uses a mixture of SUTs and IOTs (in various details and dimensions, i.e. industries and commodities).

30. Concerning the sectorial details IDE-JETRO, OECD-WTO and WIOD mostly provide data at the 2-digit levels and even further aggregates and do not further disaggregate industries or commodities and therefore aim at a common industry classification which can be achieved for each country. EXIOBASE undertakes a further disaggregation of the SUTs based on various data and assumptions. The GTAP-MRIO takes over the industry classification as used in the GTAP project. Finally, the EORA database uses the most detailed information which is available by country; data for other countries are estimated at a common industry classification.

31. *Benchmarking to National Accounts* (NA) data: In all cases – apart from the GTAP-MRIO which is based on the GTAP trade data – the tables are benchmarked to the recent and revised SNA data before further processing to calculate the multi-country dimensions. However, this is done in various ways. In the EORA approach benchmarking to SNA (and other) data occurs within a large-scale optimisation approach also providing valuation matrices and the multi-country tables. In the other cases this is mostly performed before the construction of international tables for each individual SUT. In the EXIOBASE project this is achieved using a non-linear programming approach applied to the constructed more detailed SUTs. In the IDE-JETRO and WIOD approach this has been achieved by a RAS or SUT-RAS procedure (see Temurshoev and Timmer, 2011), respectively. The OECD-WTO TiVA database seem first to adjust trade data (taken from SUTs and SNA) to provide a consistent bilateral trade flow matrix to which SUTs are adjusted by using a constrained quadratic mathematical programming procedure.

32. *Estimation of valuation tables*: An important step in all efforts to construct MC-IOTs is to transform use tables in purchasers' prices into use tables in basic prices, i.e. to construct valuation matrices for 'taxes less subsidies' (TLS) and 'trade and transport margins' (TTM). For constructing GTAP-MRIO this is already taken into account in the underlying GTAP data; in the EORA effort this is performed as part of the large-scale optimisation approach. In three out of the other four cases – EXIOBASE, IDE-JETRO, OECD-WTO TIVA initiative – valuation matrices for TTM and TLS and therefore use tables (or IO tables) in basic prices are either taken from existing information or calculated using existing information (e.g. from previous years, etc.) to the extent possible (see Rueda-Cantuche et al. (2013), for an evaluation effort). Consistency is assured by applying RAS-like or optimisation procedures. In the WIOD project, it was opted to estimate valuation matrices and therefore use tables in basic prices based on a common procedure (the SUT-RAS procedure) for all countries (thus, even if valuation matrices have been available). It should be noted that now a number of countries also report use tables in basic prices which can be used instead of constructing them.

33. *Construction of import use tables*: The construction efforts of import use tables (in most cases, valued in cif) are partly in line with the construction methods of valuation matrices across the various datasets considered. The EXIOBASE, IDE-JETRO and OECD-WTO approaches relied on available information as above (i.e. further construction of import use tables has only been done in case no prior information has been available). IDE-JETRO undertook a specific survey (for the data for 2005) to achieve better information

concerning the imports of the using industries (to avoid proportionality assumption). GTAP-MRIO applies a proportionality method to construct import use tables (based on shares of the importing country). In the EORA database, this is achieved within the large-scale programming approach (based on available information). In the WIOD project, import use tables have been estimated for all countries based on the same procedure (i.e. information from existing import use tables has not been used at this time).

34. In all cases where import use tables had to be constructed a kind of proportionality assumption has to be applied. This means, that the imports (from the information given in the supply tables) are allocated over the using industries proportional to the use of commodities in the total use table (in basic prices). At least in the OECD-WTO and WIOD, they applied a modified proportionality assumption by splitting import use into various use components (intermediates, consumption, gross fixed capital formation) with information derived from detailed trade data. In these cases import levels of a specific product are first split into these three categories which are then allocated proportionally over the various use categories (e.g. the industries in case of intermediate imports). This modifies a 'pure proportional assumption' though, however, one has to bear in mind that within these 'use categories' still the proportionality assumption had to be applied (particularly across all using industries). Similar to information on valuation matrices, it should be noted that an increasing number of countries (particularly, European countries) are reporting import use tables, which can be used in the construction methods.

4. Trade data

35. Detailed trade data are important in the construction process of IC-SUIOTs generally for (i) information in the construction of import SUIOTs (as just outlined above) by users and for the geographical breakdown of the import SUIOTs by source country.

36. Table A.4 (see Annex) reveals that the most important data source for trade in goods is the UN COMTRADE data which are then often modified and balanced (or reconciled) beforehand. Data on trade in services are more challenging given some inconsistencies within and across various datasets, missing information on details (e.g. bilateral flows by detailed BoP categories) and lack of correspondence between BoP codes and the CPA classification.

37. However, the various approaches differ with respect to the sequence of adjustments. The OECD-WTO TiVA and WIOD start from a previously balanced dataset (i.e. mirror flows are matched) which is achieved in various ways (e.g. WIOD relies on import and mirrored import data only). These trade data are then adjusted to the information on imports and exports from the SUTs under consideration of cif/fob. margins which need to be estimated separately. Imports and exports by commodity are also adjusted beforehand in the OECD-WTO TiVA approach to satisfy information from SNA data. In the EXIOBASE project, trade data are first used to split out import use tables (in cif) which are then made consistent applying a non-linear programming approach (cif/fob adjustments are applied later in the process). In the IDE-JETRO approach some further information is collected from national sources; however the global balancing issue in this case is less relevant (as part of exports are from exogenous countries and regions). In the EORA project trade relations are included in the large-scale optimisation approach as a further constraint. And, finally, in the GTAP-MRIO project the trade data form the basis from the beginning on to which IOTs are benchmarked.

38. A second important aspect is the split of imports (and exports) by various categories: intermediates, final consumption and gross fixed capital formation. This has implications as outlined already above in the process of constructing import use tables as well as in the process of splitting up import use tables by source country. Consumption patterns (or structures) might differ between intermediates, final consumption and gross fixed capital

formation. Only the OECD-WTO and the WIOD project attempt to do it by using a 'modified BEC classification'. In such cases, trade data at the detailed 6-digit HS product level were classified as intermediates, final consumption or gross fixed capital formation, based on the UN BEC classification; in both cases, the BEC classification was somewhat improved and adjusted to account for multi-use products.

39. These aspects are even more relevant concerning trade in services. First, statistics on trade in services (UN, Eurostat, OECD, etc.) are rather incomplete concerning the number of trading partners in detailed categories, lack of match of trade flows concerning mirror flows, inconsistencies across various levels of aggregation, etc. Therefore, these data need to be heavily adjusted in various attempts. As far as we know, the OECD-WTO imputes data by mirroring flows and also on the basis of gravity model estimates. The WIOD project aimed at providing a consistent database by combining various sources, building mirror flows and making them consistent across various aggregates. This was similarly the case for the GTAP-MRIO data, which rely on GTAP trade data (though from much earlier years). IDE-JETRO also used information from national statistics.

40. The second issue concerns again the split of imports by use categories which cannot be done – even if incomplete – on the basis of trade data as, differently to merchandise trade, no such detailed information is available.

41. The third important challenging issue is the lack of correspondence between BoP categories (in which trade in services data are classified) and the CPA categories, where only broad correspondences have been applied. Due to the lack of better information these have often been built by judgement of the relevant institutions.

5. Re-exports and cif/fob adjustments

42. Re-exports and cif/fob adjustments are crucial for the construction of import use tables, the reconciliation of SUIOTs with trade data sources and the construction of import SUIOTs by country of origin. However, the related documentation is not often available or not detailed enough to provide a good overview of existing approaches to these challenges (maybe reflecting the difficulty in addressing them).

43. *Re-exports*: In some cases such as the GTAP-MRIO MC-IOTs, re-exports have already been treated in the construction of the GTAP trade data. In the EORA approach, re-exports are most likely built in the large-scale optimisation procedure. Comparing the other two approaches where re-exports are explicitly tackled, the OECD-WTO TiVA procedure defines re-exports (by commodity) as the values provided in the import use tables (and the estimated variants). In the WIOD project, re-exports were defined in case of imports being larger than total domestic use. In both approaches, those re-exports were not further integrated back into the system basically as this would have changed the already balanced domestic and import SUTs (see Streicher and Stehrer, 2015).

44. *Cif/fob margins*: This issue arises as imports in the supply table (in basic prices) are valued in cif terms whereas exports (in the use tables both in purchasers' and basic prices) in fob terms. Thus, constructing an import use table based on imports cif and stacking them into a global use table does not match with the trade flows interpreted along the rows as exports (which are then by definition in cif). Again, in some approaches this does not matter at all since imports are provided in fob terms (or at least with information on cif/fob margins) like the GTAP data. In the EORA documents, this is mentioned but not further detailed out. For constructing the IDE-JETRO tables a specific survey has been undertaken to reveal the magnitudes of those international cif/fob margins which – by the way – are only relevant for trade in goods.

45. In the EXIOBASE approach, the difference between the total value of (global) imports and exports has been used to quantify the overall magnitude of cif/fob margins.

Based on such information, the magnitudes of cif/fob margins by commodity-country pairs were approximated. Then, by subtracting this difference (based on a proportionality assumption) from the import use tables in cif and applying GRAS, it resulted in a global import use table in fob terms with its corresponding valuation matrix. In the OECD-WTO approach, cif/fob margins have been estimated based on a gravity models and used as an additional constraint in the 3-step constrained quadratic mathematical programming procedure applied for the construction process of MC- IOTs.

46. The cif/fob margins in the WIOD project have been estimated based on detailed trade data and a gravity approach. The overall magnitude of the cif/fob margins is quantified as the export surplus (over total domestic supply) in the transport and trade services sectors. Combining these two pieces of information, i.e. the overall level and the bilateral cif/fob ratios by commodity and country-pair allow calibrating the trade matrix with constraints (import and export levels) stemming from the SUTs and the initial values for bilateral trade (coming from trade data statistics) using a RAS (or similar) procedure. This resulted in a global international trade and transport valuation matrix (cif/fob margins) consistent with the global SUTs system.

47. These approaches so far only correct for the use of international trade and transport services; in neither of these approaches however the supply of these services is treated or modelled completely satisfactorily (with the exception of Streicher and Stehrer, 2015).

6. Construction of global multi-country SUIOTs

48. The final step in all of these efforts is the construction of a global SUIOT, which (for the IOT dimension) is the most important tool for applications. As indicated in Table A.6 (see Annex), this step is not needed in all cases. The EORA data already provide a global MC-IOT though mixing product and industry dimensions and various levels of details across countries. The downloadable version reports 25 ‘industries’ though these are aggregated from both industry and product dimensions across countries. The GTAP-MRIO also starts from a globally balanced system of trade data to which (national) IOTs have been benchmarked. In this case an effort has been undertaken to split these IOTs to account for trade in intermediates resulting in a global MC-IOT. The IDE-JETRO approach starts basically from national IOTs and therefore results in an MC-IOT.

49. Concerning the remaining datasets, they all provide global SUTs with supply tables in basic prices and international use tables in basic prices (with valuation matrices for trade and transport margins and taxes less subsidies) and imports in fob terms, i.e. net of cif/fob margins. Stacking these data appropriately corresponds – to a certain extent – to a national total table in basic prices. Therefore, the various models for constructing IOTs from SUTs (e.g. see Eurostat manual, 2008) can be applied. The OECD-WTO and WIOD report industry-by-industry global MC-IOTs based on Model D (fixed product sales structure assumption); while EXIOBASE provides various IOTs (product-by-product and industry-by-industry) based on the various well-known technology assumptions (industry technology assumption – Model B – and Model D, respectively).

50. A specific challenge in the construction of a global MC-IOTs is the construction of the rest-of-world region, which in most cases is characterised by about 10-15% of the global GDP and trade (depending on country coverage) – e.g. EXIOBASE and WIOD. In most cases, the countries left out may be important providers of raw materials (which impacts particularly on environmental footprints). In some cases (EORA and GTAP-MRIO) a rest-of-world region is provided mostly to assure the balancing of the system, i.e. world exports match world imports (by product or industry and global value added matches global final demand). Estimates for the rest-of-world region are based on estimates of output, value added and final demand from various sources (e.g. UN, UNIDO). Given the lack of detailed data, input structures are often based on a benchmark country or a set of

countries. In the EXIOBASE data, this is done on a product-specific basis. Trade flows of the rest-of-world region with the countries in the datasets are determined by the residual of trade between the countries in the data and the total exports and imports (already reconciled with trade data). Input-output structures are also approximated from the benchmark countries (e.g. WIOD) or further manually adjusted (e.g. EXIOBASE). Finally, RAS procedures are applied to fit the rest-of-world region into the overall system such that the world global accounting identities are satisfied (for an overview of methods and outcomes, see Stadler et al, 2014) and avoid assuming "the world is exporting goods to Mars".

7. Closing the review

51. For more details on the different methods addressed in this review, it is advisable to read the special issue of Economic Systems Research (Volume 26, Number 3, and September 2014) for an assessment of the various datasets. Besides, Arto et al (2014), Owen (2015) and Jones et al (2014) provided a comparison of various MC-IOTs (GTAP, OECD-WTO, WIOD).

V. Methodology for the construction of EU Inter-Country Supply, Use and Input-Output Tables

52. This document describes the method Eurostat is developing to construct the EU Inter-country Supply, Use and Input-Output tables. The approach builds on the latest developments of the OECD (Fortanier and Sarrazin, 2016; Fortanier et al, 2016; Miao and Fortanier, 2016) regarding the construction of balanced bilateral trade statistics.

53. Following Fortanier and Sarrazin (2016), the full process for the construction of the EU IC-SUIOTs is also characterised by the following key features: transparency; modularity; collaboration and collective ownership; and long-term perspective.

54. Regarding *transparency*, it means that any necessary adjustment of the reported official data will be well-documented and the balancing procedure shall be based on simple and transparent calculations (e.g. weighed symmetry index), thus avoiding mathematical model-based optimisations.

55. The construction of the EU Inter-country Supply, Use and Input-Output tables (EU IC-SUIOTs) involves different steps (or *modules*) that are described in a flow chart (see Figure 1 in the Annex). The full process pivots around five main blocks of (official) **source data**: national accounts (as benchmark), national supply and use tables, national input-output tables, international merchandise trade data and international services trade data. All of them are used to construct the three main **data inputs** feeding the construction process of the EU IC-SUIOTs, i.e. a balanced bilateral trade database (for goods and services), a full set of national supply and use tables and a full set of national input-output tables.

56. The EU IC-SUIOTs is designed to continuously build on the work of EU national statistical offices in order to increase mutual collaboration and gain *collective ownership* at the EU level. The same applies to other international agencies.

57. The project has a *long time-horizon* and it aims to be a permanent source of data for users with frequent updates and annual (and five-yearly) publications.

1. Preparing data inputs

58. The first step is to collect and prepare the source data. A collection of *national supply and use tables* (at basic prices) with a distinction between domestic and import uses shall be prepared. There are some missing countries that will be estimated using a set of good practices guidelines developed by Eurostat and the DG Joint Research Centre (Rueda-

Cantuche et al, 2013). These estimates will already be benchmarked with the latest figures of National Accounts. The sectorial classification is NACE Rev. 2 and the commodity classification refers to CPA 2008. The tables comprise 64 industries and 64 commodities, which can also be easily referred to ISIC Rev. 4 classification.

59. A collection of *national input-output tables* with a distinction between domestic and import uses shall also be prepared. In this case, the missing input-output tables will be estimated using the industry technology assumption (Model B, in Eurostat, 2008) for product by product IO tables and the fixed product sales structure assumption (Model D, in Eurostat, 2008) for industry by industry IO tables.

60. The process is less straightforward regarding the construction of a *bilateral balanced trade dataset* for goods and services trade. For merchandise trade data, we will use the EU COMEXT (Intrastat and Extrastat) database at the CN-8 digit level as starting point. The trade data shall be corrected for the biggest trade asymmetries (most likely manually) and, provided that imports are valued cif and exports are valued fob, later adjusted with the appropriate cif/fob margins correction. A correspondence table between CN-8 digit (and also HS-6 digit for non-EU countries) and CPA 2-digit will also be elaborated.

61. Next, the reconciliation process of bilateral trade flows shall be based on a symmetry index (or reliability index) calculated to compute a weighted average of the two reported values available for each bilateral trade flow. This process basically follows the same philosophy as the OECD reconciliation methodology (Fortanier and Sarrazin, 2016). Finally, one important issue before the final balancing is the treatment of not geographically specified trade, which in some cases can be very important (e.g. German and Austrian trade in petroleum and natural gas). Other frequent problems need also to be tackled by trade statisticians before coming out with a final balanced bilateral merchandise trade dataset: misclassification of products, incoherent application of methodologies, treatment of vessels and aircrafts, confidential trade, among others.

62. The estimation of cif/fob margins by product and partner of each bilateral trade flow will be based on the estimations made by national statistical institutes. Otherwise, we will follow the approach suggested by Miao and Fortanier (2016). They use a gravity model based on geographical distance, GDP per capita, average annual oil price, worldwide median unit values (at HS-6 digit level) and dummy variables reflecting contiguity of countries and the continent of trading partners. From Miao and Fortanier (2016), we know that there are national data at least for Luxembourg, the Czech Republic and Slovakia.

63. Regarding international services trade data, the estimation process of missing trade data can be more burdensome than for merchandise trade data due to the lack of available information and the fact that services trade is measured in a different classification (EBOPS categories) system. Following Fortanier et al (2016), the process will be designed as top-down, meaning that we will first develop a complete dataset of trade in services (total) with partner rest of the EU and rest of the World (step 1) and then, we will quantify all their main EBOPS categories (step 2). Subsequently, we will use a gravity model to estimate the missing total trade in services by partner country (step 3) and their main EBOPS categories later on (step 4). The gravity model will use independent variables such as GDP of reporter and partner countries, distance, contiguity, common language, GDP per capita of reporter, bilateral merchandise exports, among others, to explain/estimate the exports of total services.

64. Once a full dataset of bilateral trade flows of services data is completed, then the same balancing approach and principle (symmetry index) set out in Fortanier and Sarrazin (2016) will be applied. Differently from merchandise trade data, the resulting balanced bilateral trade dataset will eventually have to be converted from EBOPS categories into

CPA products using a combination of EBOPS-CPA conversion tables, SUIOTs and STEC data (Services Trade by Enterprise Characteristics).

65. As such, the balanced view of bilateral trade achieved in previous steps may differ from the totals of trade in goods and trade in services provided by National Accounts. These differences will have to be reconciled depending on the product being reconciled:

(a) *Goods sent for processing* would require reductions in the exports and imports of the country controlling the "good for processing" as long as these flows are already recorded in that country's merchandise trade data.

(b) *Merchanting transactions* would require positive adjustments in exports and imports to ensure that the balanced view of merchandise trade data includes the merchanting margins applied by the merchanting country and the amounts paid by the importer for such merchanting services.

(c) *Direct purchases* abroad by residents (imports) and direct purchases in the domestic territory by non-residents (exports); typically included in National Accounts as a lump-sum total but not separated by product. Nonetheless, these flows are reported by international services trade data under the "Travel" item in EBOPS categories and therefore, they need to be separated from pure travel services using Tourism Satellite Accounts, SUIOTs or any other related source data. The estimated values will then be transferred to the goods categories.

(d) *Re-exports*; sometimes countries may report only the net trade (export minus imports) in National Accounts so gross figures of both exports and imports will have to be estimated and added to National Accounts data while maintaining the net balance and the GDP unchanged.

(e) *Unobserved transactions* include a varied range of flows from smuggling to small scale transactions (under certain administrative threshold); these can only be aligned with National Accounts through RAS-type bi-proportional adjustments.

66. As a result, these adjustments will bring in new unbalances in the bilateral trade dataset that will have to be solved using RAS-type bi-proportional methods.

2. The construction of the EU Inter-country Supply and Use tables

67. Once the balanced bilateral trade dataset of goods and services is ready and the full set of national supply and use tables prepared, the next challenge is to build in the EU Inter-country Supply and Use tables respecting the trade values of the national SUIOTs (although they might well be adjusted later on to reflect the latest National Accounts data). Figure 2 (see Annex) illustrates the Eurostat format of the EU IC-SUTs and identifies the information collected through the national SUTs.

68. The total exports by exporting country and product from national SUTs (e.g. German exports of vehicle parts) is split up across countries of destination (importing countries) using the geographical shares obtained from the balance bilateral trade dataset. Further use of STEC and TEC data as well as the UN Classification of Broad Economic Categories (BEC) may provide more insight in the differentiation between intermediate and final exports. The allocation across user industries is eventually made using (proportions of) the rows of the import use tables. Notice that in the absence of STEC, TEC and BEC data, the import use table can also provide a certain differentiation between intermediate and final exports.

69. However, as a result of the above split, the total imports by product and country have changed and do not comply with SUTs totals any more. Therefore, the initial geographical partner shares will have to be modified in such a way that neither total imports nor total exports by product and country changes any more. It is most likely that a RAS-type adjustment might be needed at this point to balance the full EU IC-SUT (at least for smaller values).

70. The last step would be to benchmark the resulting EU IC-SUTs to the latest National Accounts totals by using RAS-type adjustments. These type of adjustments allow for a minimal deviation with respect to the base (or initial) matrix.

3. The construction of the EU Inter-country Input-Output tables

71. The construction of the EU Inter-country Input-Output tables shall be based on the already estimated EU IC-SUTs. For product by product IO tables, the final demand component remains unchanged by definition so no further changes need to be made in the final demand component of the EU IC-IOTs. The changes will therefore affect only to the intermediate uses by exporting country, trade partner and product and value added by country and product. The final EU IC-IOT will have to respect the official values of the national IO tables and the estimated IO tables of missing countries (based on Model B, Eurostat 2008). Regarding industry by industry IO tables, intermediate and final uses (from the EU IC-SUTs) will have to change by definition while value added would remain unchanged. In such case, Model D (Eurostat, 2008) will be used for estimating the missing IO tables while the official IO tables will have to be respected. In doing all these estimations, the geographical partner shares will suffer further adjustments in order to reflect the exogenous information included in official IO tables.

VI. Next steps

72. As of April 2016, we are currently carrying out the process of data collection and preparation. The estimation of missing national SUTs has been completed for the purpose of constructing the EU Consolidated Supply, Use and IO tables. Of course, if new data are transmitted in the near future, they will replace our estimations. Regarding missing IO tables, we prefer waiting until further stages of the project to estimate them just in case a new submission will be sent to Eurostat. The same applies to National Accounts data; they will be collected at further stages of the project just in case new revisions come in.

73. From now onwards, most of the efforts will be put in estimating the EU balanced bilateral merchandise trade and services trade dataset. The Eurostat teams of “Trade in Goods” and “Services Trade” are working on the necessary adjustments to the database as outlined above. The expected deadline for a first preliminary EU IC-SUIOTs is December 2016.

74. This document describes the work carried out so far on the inception of the project, the review of the methods for the construction of global IO tables and the methodological proposal for the production of EU IC-SUIOTs under the project FIGARO.

References

Arto, I., J. M. Rueda-Cantuche and G. Peters (2014), "Comparing the GTAP-MRIO and WIOD databases for carbon footprint analysis", *Economic Systems Research*, 26 (3), pp. 327-353.

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

Fortanier, F., A. Liberatore, A. Maurer and L. Thomson (2016), "Towards a global matrix of trade in services statistics", Working Party on International Trade in Goods and trade in Services Statistics, March 2016, Paris: OECD.

Fortanier, F. and K. Sarrazin (2016), "Balanced international merchandise trade data: Version 1", Working Party on International Trade in Goods and trade in Services Statistics, March 2016, Paris: OECD.

Jones, L., Z. Wang, L. Xin, and C. Degain (2014), "The Similarities and Differences among Three Major Inter-Country Input-Output Databases and their Implications for Trade in Value-Added Estimates", Office of Economics Working Papers No. 2014-12B, U.S. International Trade Commission.

Owen, A.E. (2015), *Techniques for Evaluating the Differences in Consumption-Based Accounts: A Comparative Evaluation of Eora, GTAP and WIOD*, Thesis.

Rueda-Cantuche, J. M., Beutel, J., Remond-Tiedrez, I. and Amores, A. F. (2013), *Good practice guidelines in the estimation of use tables at basic prices and valuation matrices for multiregional input-output analysis*, Report to the European Commission's Joint Research Centre under the Contract Project: "European and Euro Area Time Series of Supply, Use and Input-Output Tables in NACE Rev.2, current and previous year prices (2000-2009)".

Stadler, K., K. Steen-Olsen and R. Wood (2014), "The 'Rest of World' – Estimating the Economic Structure of Missing Regions in Global Multi-Regional Input-Output Tables", *Economic Systems Research*, 26 (3), pp. 303-326.

Stehrer, R. and J. M. Rueda-Cantuche (2016), "Review of the Methods for the estimation of Global Multi-country Supply, Use and Input-Output tables", Final Report to the European Commission's Joint Research Centre. Unpublished version.

Streicher, G. and R. Stehrer (2015), "Whither Panama? Construction a consistent and bilateral world SUT system including international trade and transport margins", *Economic Systems Research*, 27 (2), pp. 213-237.

Temurshoev, U. and M.P. Timmer (2012), "Joint Estimation of Supply and Use Tables", *Papers in Regional Science*, 90, pp. 863-882.

Appendix A

Table A.1 – Selected basic information on existing multi-country input-output tables

Database	Website:	Countries	Industries	Years	Quality reports/ Robustness checks	Availability of tables	Potential Updates/ revisions
EORA	http://worldmrio.com/ http://www.worldmrio.com/simplified/	187	Varying across countries; simplified version with 26 industries	1990-2012	Yes	Yes	Yes
EXIOBASE	http://www.exiobase.eu/	44 countries; 5 world regions	200 products; 163 industries	2000; 2007	No	Yes	Yes (annual time series from 2016 on)
GRAM	http://www.materialflows.net/home/	228 countries	n.a.	n.a.	No	No	n.a.
GTAP-MRIO	https://www.gtap.agecon.purdue.edu/	140 GTAP countries and regions	57 GTAP commodities	1990, 1992, 1997, 2001, 2004, 2007	No	Only up to GTAP7	Infrequently
IDE-JETRO (AIIOT)	http://www.ide.go.jp/English/Data/Io/index.html	10 countries	76 sectors	1985; 1990; 1995 ; 2000; 2005	No	2005	n.a.
OECD-WTO TiVA	http://www.oecd.org/trade/input-outputtables.htm	62 countries (incl. RoW)	34 industries	1995; 2000; 2005; 2008-2011	No	Yes	Ongoing
WIOD	http://www.wiod.org/new_site/home.htm	41 countries (incl. RoW)	35 industries	1995-2011	No	Yes	Ongoing
YNU-GIO	http://www.recessa.ynu.ac.jp	29 countries and 5 world regions	35 industries	1997-2012	No	Yes	n.a.

Note: Information taken from websites; this table does not include information on satellite accounts; industry classifications mostly correspond to NACE Rev. 1 / ISIC Rev. 3.

Table A.2 - Dimensionality

Dimension	EORA	EXIOBASE	GTAP-MRIO	IDE-JETRO	OECD-WTO	WIOD
Number of countries	187 countries; RoW as residual	43 countries; RoW	114 countries; 14 regions; RoW	10 countries; 4 exogenous regions (incl. RoW)	62 countries (CHN and MEX split); RoW	40 countries; RoW
Number of industries	26	163	57 (of which 20 agricultural)	76	34	35
Period	1990-2011/2012	2000, 2007	Latest years: 2004 (base year), 2007	1975, 1985, 1995, 2000, and 2005	1995, 2000, 2005, 2008, 2009, 2010, and 2011	1995-2011

Source: Stehrer et al (2016)

Table A.3 – Data sources

	EORA	EXIOBASE	GTAP-MRIO	IDE-JETRO	OECD-WTO	WIOD
Base data	IOTs, SUTs	SUTs; IOTs to estimate SUTs	GTAP trade data	IOTs	SUTs; IOTs to estimate SUTs	SUTs
	Different dimensions	Further disaggregation	Sector level determined by GTAP trade data	Aggregation to common level	Adjusted to common classifications	Adjusted to common classifications
Harmonisation/ Benchmarking to SNA	SNA data as constraints in large-scale optimisation approach	SUTs benchmarked to SNA	Based on GTAP data (balanced beforehand)	IOTs benchmarked to SNA	SUTs benchmarked to SNA	SUTs benchmarked to SNA
Valuation (USEpp to USEbp)	Constructed during large-scale optimisation approach	Based on/estimated from existing information; or 'similar country assumption'	Based on GTAP data providing information on international margins (and taxes)	Based on/estimated from existing information	Based on/estimated from existing information	Estimated using SUT-RAS procedure
Import use tables	Constructed during large-scale optimisation approach	Based on existing information or 'similar country assumption'	Constructed using proportionality assumption	Based on existing information; in 2005 specific survey conducted	Mostly based on available information; else estimated using modified proportionality assumption	Constructed from imports in SUP using modified proportionality assumption

Source: Stehrer et al (2016)

Table A.4 – Trade data: sources and adjustments

	EORA	EXIOBASE	GTAP-MRIO	IDE-JETRO	OECD-WTO	WIOD
Trade in goods	UN COMTRADE	UN COMTRADE	UN COMTRADE; balanced and consolidated	UN COMTRADE; national sources	OECD data based on UN COMTRADE; Modified UN BEC classification	UN COMTRADE; import data; Modified UN BEC classification
Trade in services	UN Services Trade Database	UN Services Trade Database	UN Services Trade Database, Eurostat, OECD adjusted	UN Services Trade Database; national sources	OECD-WTO TiS (based on Eurostat, UN, IMF); various imputation strategies	UN Services Trade Database, Eurostat, OECD adjusted; Modified proportionality assumption

Source: Stehrer et al (2016)

Table A.5 – Treatment of re-exports and CIF/FOB margins

	EORA	EXIOBASE	GTAP-MRIO	IDE-JETRO	OECD-WTO	WIOD
Re-exports			Already built-in in balanced trade data		Export column in import use tables; leave system	Defined as exports larger than domestic use; leave system
cif/fob adjustment		Difference between total value of imports and exports; GRAS procedure	Data already in fob	For 2005 specific survey undertaken	Bilateral cif/fob margins estimated with gravity	Bilateral cif/fob margins estimated with gravity
		Valuation matrix as difference between ImpUSEbcif and ImpUSEbfob			Adjustments in 3-step constrained quadratic mathematical programming procedure	RAS procedure when reconciling with SUTs export and import levels

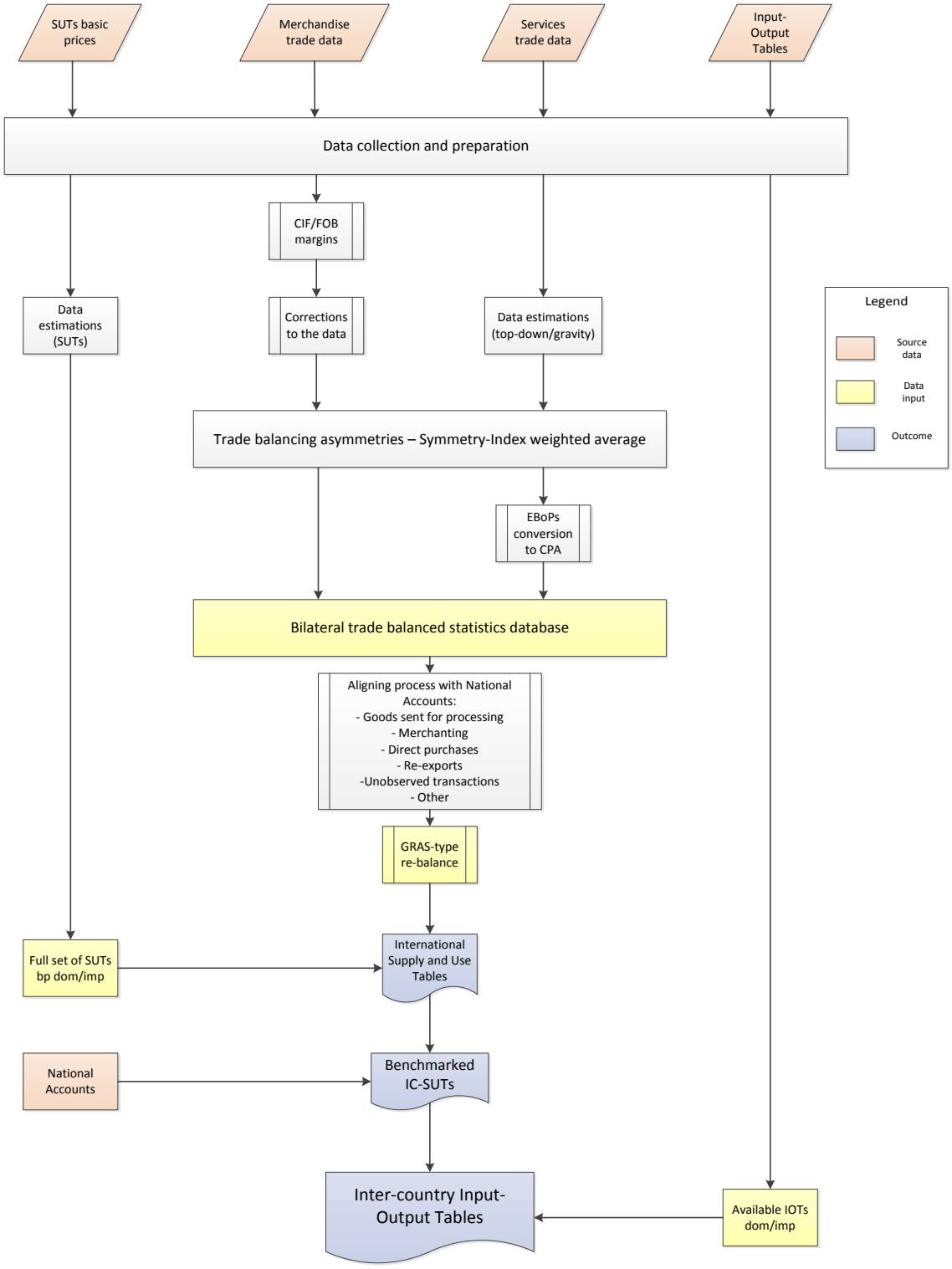
Source: Stehrer et al (2016)

Table A.6 – Construction of MC-IOTs

Column1	EORA	EXIOBASE	GTAP-MRIO	IDE-JETRO	OECD-WTO	WIOD
Construction of IOTs	Not necessary	Various	Not necessary	Not necessary	Model D	Model D

Source: Stehrer et al (2016)

Figure 1. FIGARO's methodology flow chart



FIGARO Project: The EU Inter-country Supply, Use and Input-Output Tables (April 2016)

Figure 2. FIGARO's EU IC-SUIOT format