



Report D7.1

Update EXIOBASE apart from WP3-6 input

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CREEA

Compiling and Refining Environmental and Economic Accounts

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About CREEA

The main goal of CREEA is to refine and elaborate economic and environmental accounting principles as discussed in the London Group and consolidated in the future SEEA 2012, to test them in practical data gathering, to troubleshoot and refine approaches, and show added value of having such harmonized data available via case studies. This will be done in priority areas mentioned in the call, i.e. waste and resources, water, forest and climate change / Kyoto accounting. In this, the project will include work and experiences from major previous projects focused on developing harmonized data sets for integrated economic and environmental accounting (most notably EXIOPOL, FORWAST and a series of EUROSTAT projects in Environmental Accounting). Most data gathered in CREEA will be consolidated in the form of Environmentally Extended Supply and Use tables (EE SUT) and update and expand the EXIOPOL database. In this way, CREEA will produce a global Multi-Regional EE SUT with a unique detail of 130 sectors and products, 30 emissions, 80 resources, and 43 countries plus a rest of world. A unique contribution of CREEA is that also SUT in physical terms will be created. Partners are:

1. Nederlandse Organisatie Voor Toegepast Natuurwetenschappelijk Onderzoek (TNO), Netherlands (co-ordinator)
2. JRC -Joint Research Centre- European Commission (DG JRC IPTS), Belgium /Spain
3. Universiteit Leiden (Unileiden), Netherlands
4. Centraal Bureau voor de Statistiek (CBS), Netherlands
5. Norges Teknisk-Naturvitenskapelige Universitet (NTNU), Norway
6. Statistiska Centralbyran (SCB), Sweden
7. Universiteit Twente (TU Twente), Netherlands
8. Eidgenössische Technische Hochschule Zürich (ETH) Switzerland
9. 2.-0 LCA Consultants Aps (2.-0 LCA), Denmark
10. Wuppertal Institut Fur Klima, Umwelt, Energie Gmbh. (WI), Germany
11. SERI - Nachhaltigkeitsforschungs Und -Kommunikations Gmbh (SERI) Austria
12. European Forest Institute (EFI), Finland / Spain

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Executive Summary

This report covers the preparation of harmonized MR MSUT tables including labour extensions (WP7). The report covers the full data processing from preparation of source data to producing final MR SUT tables. The main goal of the development of the EXIOBASE database within CREEA is to operationalize the economic and environmental accounting principles as discussed in the London Group and consolidated in the future SEEA 2012. The focus is on practicalities of implementing SEEA guidelines with respect to data gathering, the refinement of approaches for allocating supply-chain impacts, and the demonstration of global impacts across the production-consumption perspectives. Most data gathered in CREEA will be consolidated in the form of Environmentally Extended Supply and Use tables (EE SUT). The work of WP 7 is to integrate the outputs on the environmental extensions of WP3-6 with a harmonized, trade-balanced and disaggregated system of Supply and Use Tables, in a global context. This thus provides a basis for later MRIO analysis. This document describes the process of arriving at such an integrated database, as far as the economic component concerns (i.e. construction of an MR MSUT). Task 7.2 will describe the full database including production of extensions.

Aspects addressed in CREEA that push forward the state of the art include: Increased country detail; increased product/industry detail; Rectangular instead of square (EE) SUT; Expanding Monetary SUT to Physical SUT(the latter described in D7.2). In CREEA SUTs are used as the basic building blocks for the database. Significant auxiliary data was utilized in the creation of a harmonized and disaggregated MRSUT. The summary of the steps towards making a full MRIO system for CREEA is as follows: Harmonizing and detailing SUT; Harmonizing and estimating extensions; Linking the country SUT via trade; Importing all data in EXIOBASE.

1 Introduction

The main goal of the development of the EXIOBASE database within CREEA is to operationalize the economic and environmental accounting principles as discussed in the London Group and consolidated in the future SEEA 2012. The focus is on practicalities of implementing SEEA guidelines with respect to data gathering, the refinement of approaches for allocating supply-chain impacts, and the demonstration of global impacts across the production-consumption perspectives. Most data gathered in CREEA will be consolidated in the form of Environmentally Extended Supply and Use tables (EE SUT). The work of WP 7 is to integrate the outputs on the environmental extensions of WP3-6 with a harmonized, trade-balanced and disaggregated system of Supply and Use Tables, in a global context. This thus provides a basis for later MRIO analysis. This document describes the process of arriving at such an integrated database, as far as the economic component concerns (i.e. construction of an MR MSUT). Task 7.2 will describe the full database including production of extensions.

1.1 Backgrounds on EE SUT and IOT

Multi-regional input-output (MRIO) analysis has come a long way in the last decade (Tukker and Dietzenbacher 2013). Whilst MRIO at the global scale started with exploration in the early 2000's (Munksgaard and Pedersen 2001; Lenzen, Pade, and Munksgaard 2004), the use of it for addressing issues of carbon leakage related to limiting greenhouse gas emissions (Hertwich and Peters 2009; Peters 2008; Davis and Caldeira 2010) has advanced development significantly. Now a considerable number of environmental issues congruent with "footprint" approaches use MRIO in order to fully account for life-cycle impacts of consumption (Lenzen et al. 2012; Ewing et al. 2012; Wiedmann et al. 2011; Daniels, Lenzen, and Kenway 2011; Tukker et al. 2013).

The input-output framework as exemplified by the European System of Accounts (ESA95) consists of three types of table: supply and use tables (SUT) and symmetric input-output tables (IOT)(European Communities 1996; compare UN, 1993 and UN et al.,2003).

The supply table shows the supply of goods and services, both domestic and imported, by product and type of supplier in basic prices, while the use table shows the use of

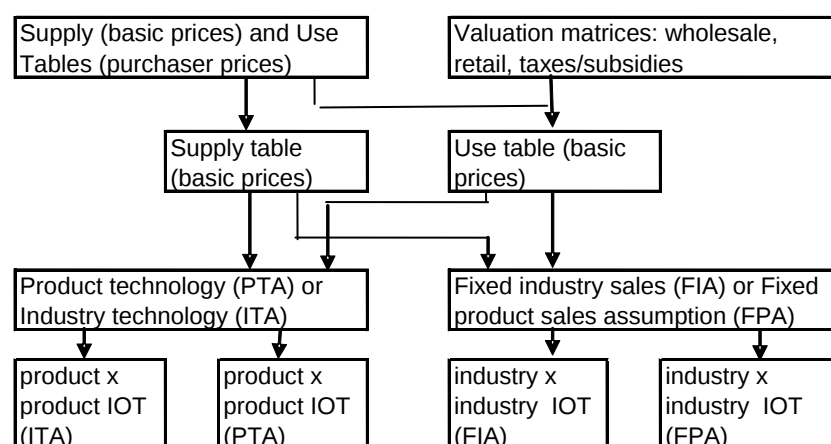


Figure 1.1: Simplified input-output framework (modified from Rueda-Cantuche et al., 2007)

goods and services by product and type of use in purchase prices, i.e. as intermediate consumption by industries, final use (consumption, gross capital formation) and exports. The use table also contains the components of the value added by industry, i.e. compensation of employees, other taxes less subsidies on

	Products	Industries			
Products		Use	Final use	Exports	Use of products
Industries	Make / Supply				Output of industries
	Imports cif	Value added			
	Supply of products	Input of industries			
		Extensions: - Primary Natural Resource input - Emissions output - etc.			

Figure 1.2: Schematic SUT with environmental extensions

production and gross operating surplus. The use table can be converted to basic prices with the help of valuation matrices reflecting retail, wholesale and taxes/subsidies per product used per industry. If necessary, the SUT can be broken down into a domestic and import (use) and an export (supply) part.

Most analytical applications and models used (e.g. CGE) are based on IOTs rather than SUT (for an exception, see e.g. ten Raa and Rueda Cantuche 2007b). Using various assumptions about technology, IOTs can be derived from the SUT in basic prices. The tables can be of a product by product type or an industry by industry type (see figure 1.1). Box 1.1 gives an example of how IOT can be constructed from SUT. We further refer to references such as Miller and Blair (1985), Ten Raa,

(2005) and EUROSTAT, 2008b, as well as Ten Raa and Rueda-Cantuche (2003 and 2007a).

SUT and IOT can be expanded with satellite accounts to indicate an industry's resource inputs from and emission outputs to the environment (see figure 1.2.)

Box 1.1: Mathematical formulation of the industry technology assumption (Model B)

Adapted from *Eurostat Manual of Supply, Use and Input-Output Tables*

In the case of the industry technology, the transformation matrix is:

$$T = (\text{diag}(g))^{-1}V$$

Hence intermediates, value added and environmental extensions of the product-by-product input-output table are:

$$S = UT$$

$$S^W = WT$$

$$S^R = RT$$

Input coefficient matrices can be derived from those by dividing the columns by the total domestic output of products.

$$A = S(\text{diag}(q-m))^{-1} = U(\text{diag}(g))^{-1}V(\text{diag}(q-m))^{-1}$$

$$A^W = S^W(\text{diag}(q-m))^{-1} = W(\text{diag}(g))^{-1}V(\text{diag}(q-m))^{-1}$$

$$A^R = S^R(\text{diag}(q-m))^{-1} = R(\text{diag}(g))^{-1}V(\text{diag}(q-m))^{-1}$$

Note that Fig. 1.2 shows an EE SUT for a single country. This leads to the problem of how to deal with imports and exports. In some cases, apparent decoupling of CO₂ emissions or primary material use from GDP growth is in fact the result of the relocation of material and energy-intensive production to other countries (Giljum et al., 2008b; Wiedmann et al., 2008). Practitioners have sought to resolve this problem by using a multi-regional approach, in which different country EE SUT or EE IOT are linked via trade to a multi-regional SUT or IOT with environmental extensions (MR EE SUT or MR EE IOT). Figure 1.3 visualizes an MR EE SUT.

Industries				$Y^*,_A$	$Y^*,_B$	$Y^*,_C$	$Y^*,_D$	q	
Products	$Z_{A,A}$	$Z_{A,B}$	$Z_{A,C}$	$Z_{A,D}$	$Y_{A,A}$	$Y_{A,B}$	$Y_{A,C}$	$Y_{A,D}$	q_A
	$Z_{B,A}$	$Z_{B,B}$	$Z_{B,C}$	$Z_{B,D}$	$Y_{B,A}$	$Y_{B,B}$	$Y_{B,C}$	$Y_{B,D}$	q_B
	$Z_{C,A}$	$Z_{C,B}$	$Z_{C,C}$	$Z_{C,D}$	$Y_{C,A}$	$Y_{C,B}$	$Y_{C,C}$	$Y_{C,D}$	q_C
	$Z_{D,A}$	$Z_{D,B}$	$Z_{D,C}$	$Z_{D,D}$	$Y_{D,A}$	$Y_{D,B}$	$Y_{D,C}$	$Y_{D,D}$	q_D
W	W_A	W_B	W_C	W_D					
g	g_A	g_B	g_C	g_D					
C & L	Capital _A	C_B	C_C	C_D					
	Labor _A	L_B	L_C	L_D					
Environ Ext	NAMEA _A	NAMEA _B	NAMEA _C	NAMEA _D					
	Agric _A	Agric _B	Agric _C	Agric _D					
	Energy _A	Energy _B	Energy _C	Energy _D					
	Metal _A	Metal _B	Metal _C	Metal _D					
	Mineral _A	Mineral _B	Mineral _C	Mineral _D					
	Land _A	Land _B	Land _C	Land _D					

Figure 1.3: Example of a MR EE SUT for 4 countries

1.2 Overview of MR EE SUT and MR EE IOT developed in CREEA

In CREEA SUTs are used as the basic building blocks for the database. Using SUTs as basis for building up an IO framework accommodates both flexibility of modelling in terms of both products as well as industries; whilst keeping tractability of data – which is usually collected for supply and use of products, by industries or activities. As such, modelling and data inventory can be kept separate.

There are several caveats to use SUTs as basic building blocks for the IO database, though. The supply of products is published in basic prices, whilst the use of products is published in purchasers' prices. In order to produce an IOT, both tables need to be in the same valuation. For this reason, valuation matrices giving taxes less subsidies and trade- and transport margins are needed to convert the use table from purchasers' prices into basic prices. Once the basic SUTs are in the right prices, transformations to the desired IOT via one of the common technology assumptions (i.e. industry technology, commodity technology, fixed industry sales structure, or fixed product sales structure assumption) is straightforward (Box 1.1).

To provide the environmental detail desired in the EXIOBASE model and to maintain consistency across nations included in the dataset we use a standard set of industries and products. The sectoral structure of the EXIOPOL database loosely follows the NACE revision 1.1 industry classifications or CPA product classification. All sectors present in the standardized Eurostat tables are also present in the EXIOBASE database. In addition, details have been added to sectors of particular importance to SEEA. The following are categories of industries for which additional details are provided in EXIOBASE:

- a) Agriculture and food
- b) Mining and raw materials
- c) Energy intensive metals production
- d) Electricity
- e) Transport
- f) Re-processing of secondary material
- g) Waste

Furthermore, significant extra detail is provided on energy products in a first step to harmonizing MRIO work with the IEA energy balances.

1.2.1 MRIO Advances

Aspects addressed in CREEA that push forward the state of the art

1. **Increased country detail.** EXIOBASE 1.0 contains 43 countries and a Rest of World. The world has over 200 countries, whereas in future for analytical purposes it could be helpful to split the bigger countries in regions. Computational limitations have previously prevented highly detailed models being operational. With advances in computational power, there is less reason to aggregate trading partners. The implication is that CREEA now includes 5 regions to describe the rest of the rest of the world, disaggregating by continental aggregates the one region of EXIOBASE 1.0. This provides a compromise for explicitly separating out different regional production practices, whilst not overloading the model with data.
2. **Increased product/industry detail.** To harmonise with the material balances of waste accounts being derived elsewhere in the project, additional detail was put into both the product and industry classification, resulting in some 200 products and 163 industries. In addition, previously artificially split processes such as refining were aggregated.
3. **Rectangular instead of square (EE) SUT.** An implication of point 2 is that we now work with a rectangular instead of square (EE) SUT. Again, EXIOBASE is fully flexible with regard to product/sector structures by country, trade linking is done via products and hence not influenced by the fact if the SUT is square or rectangular. The final transformation to IOT can then be programmed to handle rectangular SUT.
4. **Expanding Monetary SUT to Physical SUT.** An exercise undertaken in the physical accounting of this project is to expand the monetary SUT to physical SUT. The result is to express all product flows also in mass terms (dry weight). This implies that from a product perspective, the mass balance principle $\text{Supply} = \text{Use}$ will hold. CREEA also requires a consistent mass balance from an industry perspective (i.e. by industry the $\text{Supply of products} + \text{Outputs to Nature} = \text{Use of products} + \text{Inputs from Nature}$).

The last point, whilst integral to the design of work flows in WP7 is not covered here, as it forms the major work effort of WP4.

1.2.2 EXIOBASE Work flow summary

The summary of the steps towards making a full MRIO system for CREEA is as follows:

1. Harmonizing and detailing SUT

- a. Gathering SUT from the EU27 via Eurostat, and other SUT and IOT from 16 other countries (covering in total 90% of the global GDP).
- b. Harmonizing and detailing SUT with auxiliary data from FAO and a European AgriSAMS for agriculture, the IEA database for energy carriers and electricity, various resource databases for resources, etc.

2. Harmonizing and estimating extensions (described in D7.2)

- a. Allocating available resource extraction data (e.g. FAOSTAT, Aquastat) to industry sectors
- b. Allocating the International Energy Agency database for 60 energy carriers to sectors of use. Estimating emissions on the basis of energy and other activity data and TNOs TEAM model

3. Linking the country SUT via trade

- a. Splitting of Import Use tables and allocating imports to countries of exports using UN COMTRADE trade shares
- b. Confronting the resulting implicit exports with exports in the SUT, adjusting differences and rebalancing.

4. Importing all data in EXIOBASE

Exiobase, developed by CML, is a specially constructed database system with extensive reporting on errors and inconsistencies allowing for iterative improvement of the database.

1.3 Scope of this report

This report covers the preparation of harmonized MR MSUT tables including labour extensions. The physical SUT and energy SUT layers are documented in other work package reports. Other environmental extensions include land use, water use, water emissions and air emissions. Water use and emissions and air emissions are reported in other work package reports. The land use documentation will be included in a separate document. D7.2 will describe the addition of extensions on the basis of deliverables from WP3-6, and add the land use topic as a separate annex.

2 Data Flow

CREEA follows the approach in EXIOPOL of utilising the individual country SUTs as benchmark data to which all other data is reconciled to. Exceptions to this only occur where there is necessary work on harmonisation of the tables (See section 4.1). Behind the aggregate SUTs, the general data flow is designed to maximise use of high quality auxiliary data in the disaggregation of the aggregate MSUT. As per EXIOPOL, no changes were made to the aggregate MSUT unless obvious errors were encountered (negatives in the wrong place, totals not adding up. These are reviewed in Section 3). As such, auxiliary data was chosen in order to help disaggregate the MSUT to an environmentally important industry classification, to increase consistency with the ESUT, and to allow for the harmonisation of the PSUT.

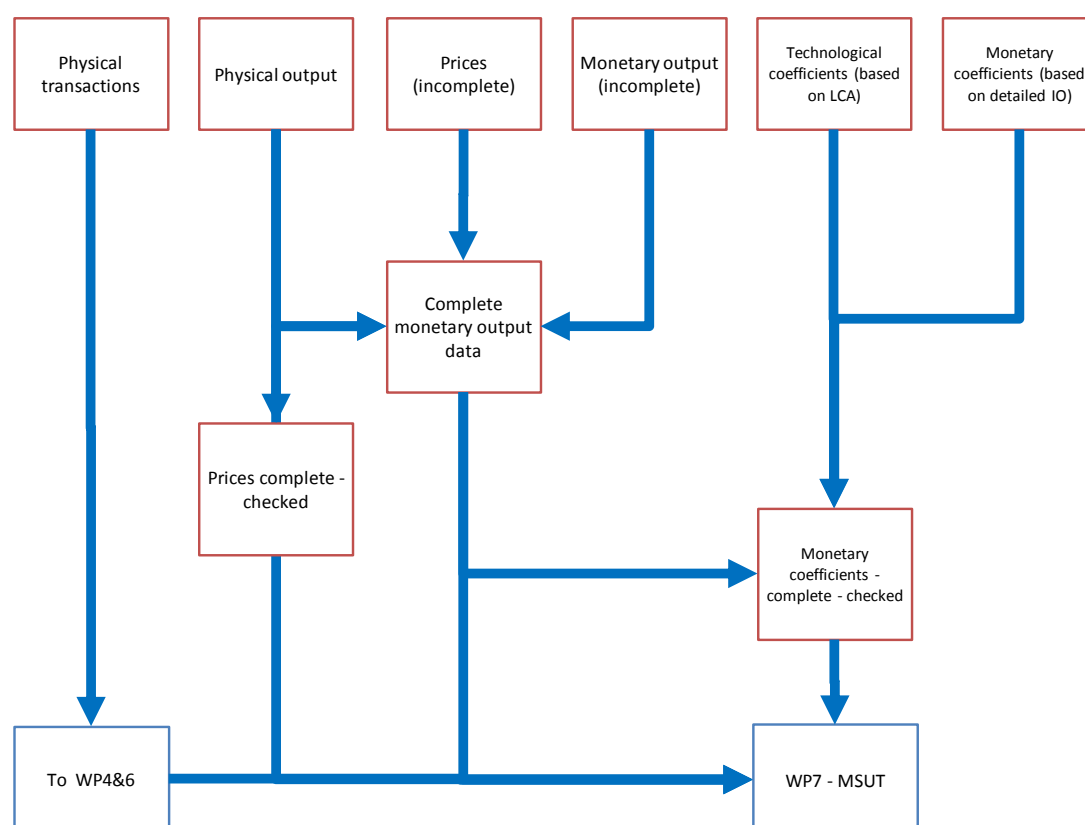


Figure 2.1: Data flow in CREEA

One challenge of the work is the large lack of consistency in source data. Even large international databases show big structural differences in them. This is complicated by the choice of maintaining connection to aggregate MSUT – which themselves embody errors. The benefit that we have in working with a full global MR SUT is that by definition, all flows must balance. Hence we are generally always working on improving source data, rather than being hamstrung by it.

The general approach integrates as much monetary data on production values in either product or industry classification as possible with physical and price data. This production data is then coupled with coefficient data in order to give first estimates on expected product-industry flows in each country. This estimate along with coefficient data from AgroSAMs and flow data from the IEA is then used to do a prior splitting of the aggregate MSUT data. The splitting is done at the cell by cell level, meaning that production balances across supply, use and auxiliary data are no longer met. This discrepancy, at least between supply and use is then resolved through mathematical programming.

3 Data sources

3.1 Aggregate MSUT

Data description

In the following table detailed information about data availability on systems of monetary supply and use tables is presented. The column of notes is mostly concerned with data on various valuation layers, but other important points could also be mentioned there. For a number of countries (China, Indonesia, India, Japan and South Korea) a lot of manual changes of original data were required, and, therefore, the description of the carried out transformation is given after the table.

All the original data, which was originally in national currency and/or for a year other than 2007, was scaled to the required year using GDP growth and converted into millions of Euros prior to disaggregation procedure.

Countries	Available raw data	Notes
EU-27		
Austria	Supply and use in purchasers' prices till 2007 in Euros (Eurostat); valuation layers of net taxes and total margins, use in basic prices for year 2006 (eeSUIOT project)	Valuation layers were provided by Isabelle Rémond-Tiedrez (Eurostat) only for confidential use
Belgium	Supply and use in purchasers' prices till 2007 in Euros (Eurostat); valuation layers of net taxes and total margins, use in basic prices for year 2004 (eeSUIOT project)	Valuation layers were provided by Isabelle Rémond-Tiedrez (Eurostat) only for confidential use
Bulgaria	Supply and use in purchasers' prices till 2005 in national currency (Eurostat); valuation layers of net taxes and total margins for year 2003 (eeSUIOT project)	Valuation layers were provided by Isabelle Rémond-Tiedrez (Eurostat) only for confidential use
Cyprus	Supply and use in purchasers' prices till 2007 in Euros (Eurostat)	For valuation layers rates of Italy are taken as proxy
Czech Republic	Supply and use in purchasers' prices till 2007 in national currency (Eurostat); use in basic prices for year 2007 (eeSUIOT project)	Use in basic prices was provided by Isabelle Rémond-Tiedrez (Eurostat) only for confidential use; for valuation layers rates of Romania are taken as proxy
Germany	Supply and use in purchasers' prices till 2007 in Euros (Eurostat)	For valuation layers rates of Austria are taken as proxy

Countries	Available raw data	Notes
Denmark	Supply and use in purchasers' prices till 2007 in Euros (Eurostat); valuation layers of net taxes and total margins, use in basic prices for year 2007 (eeSUIOT project)	In use table for 2007 there are negatives in the intermediate part, so for now year 2006 is used
Estonia	Supply and use in purchasers' prices till 2007 in Euros (Eurostat)	For valuation layers rates of Romania are taken as proxy
Spain	Supply and use in purchasers' prices till 2007 in Euros (Eurostat); use in basic prices for year 2006 (eeSUIOT project)	Use in basic prices was provided by Isabelle Rémond-Tiedrez (Eurostat) only for confidential use; for valuation layers rates of Italy are taken as proxy
Finland	Supply and use in purchasers' prices till 2007 in Euros (Eurostat); valuation layers of net taxes and total margins, use in basic prices for year 2006 (eeSUIOT project)	Valuation layers were provided by Isabelle Rémond-Tiedrez (Eurostat) only for confidential use
France	Supply and use in purchasers' prices till 2007 in Euros (Eurostat)	For valuation layers rates of Austria are taken as proxy
Greece	Supply and use in purchasers' prices till 2007 in Euros (Eurostat)	For valuation layers rates of Italy are taken as proxy
Hungary	Supply and use in purchasers' prices till 2007 in Euros (Eurostat)	For valuation layers rates of Romania are taken as proxy
Ireland	Supply and use in purchasers' prices till 2007 in Euros (Eurostat)	For valuation layers rates of Denmark are taken as proxy
Italy	Supply and use in purchasers' prices till 2007 in Euros (Eurostat); valuation layers of net taxes and total margins, use in basic prices for year 2007 (eeSUIOT project)	Valuation layers were provided by Isabelle Rémond-Tiedrez (Eurostat) only for confidential use
Lithuania	Supply and use in purchasers' prices till 2007 in Euros (Eurostat)	For valuation layers rates of Romania are taken as proxy
Luxembourg	Supply and use in purchasers' prices till 2007 in Euros (Eurostat)	For valuation layers rates of Austria are taken as proxy
Latvia	Supply and use in purchasers' prices till 2007 in Euros (Eurostat)	For valuation layers rates of Romania are taken as proxy
Malta	Supply and use in purchasers' prices till 2004 in Euros (Eurostat)	For valuation layers rates of Romania are taken as proxy

Countries	Available raw data	Notes
Netherlands	Supply and use in purchasers' prices till 2007 in Euros (Eurostat); valuation layers of net taxes and total margins, use in basic prices for year 2007 (eeSUIOT project)	Valuation layers were provided by Isabelle Rémond-Tiedrez (Eurostat) only for confidential use
Poland	Supply and use in purchasers' prices till 2007 in Euros (Eurostat)	For valuation layers rates of Romania are taken as proxy
Portugal	Supply and use in purchasers' prices till 2006 in Euros (Eurostat)	For valuation layers rates of Italy are taken as proxy
Romania	Supply and use in purchasers' prices till 2007 in national currency (Eurostat); valuation layers of net taxes and total margins for year 2005 (eeSUIOT project)	Valuation layers were provided by Isabelle Rémond-Tiedrez (Eurostat) only for confidential use
Sweden	Supply and use in purchasers' prices till 2007 in Euros (Eurostat)	For valuation layers rates of Finland are taken as proxy
Slovenia	Supply and use in purchasers' prices till 2007 in Euros (Eurostat)	For valuation layers rates of Romania are taken as proxy
Slovakia	Supply and use in purchasers' prices till 2007 in Euros (Eurostat)	For valuation layers rates of Romania are taken as proxy
United Kingdom	Supply and use in purchasers' prices till 2007 in Euros (Eurostat)	For valuation layers rates of Denmark are taken as proxy
Non EU-27		
Australia	For 2006-07 year in national currency: supply, total use in basic prices, use of imported products in basic prices, valuation layers of taxes and subsidies (4 types), trade margins (2 types), transport margins (6 types) and other margins (4 types) (ABS)	In the use table data was missing (n.p.) for the sector Water, Pipelines and Other Transport and the sector Air and Space Transport in the final demand categories. Also the concerning rows/columns didn't add up to the total. The missing amounts were estimated to achieve balance with total numbers. Use in purchasers' prices and use of domestic products in basic prices were derived from available tables.

Countries	Available raw data	Notes
Brazil	Supply and use in purchasers' prices for 2007 in national currency; supply, use in purchasers' prices, use of domestic products in basic prices and use of imported products in basic prices for 2005 in national currency (<u>IBGE</u>)	In 2005 tables activities 'Services to families and associations' and 'Domestic services' were aggregated; the split was done to gain consistency with 2007 tables. For 2005 split between margins and net taxes valuation layers was done based on EXIOPOL rates.
Canada	For 2007 in national currency: supply, use in purchasers' prices, valuation layers of trade margins (2 types), transport margins (4 types), taxes (1 type) and total use in basic prices (<u>Statistics Canada</u>)	A lot of confidential values are forced to zero, therefore could not be differentiated from real zero transactions. According to a contact person in NSI "All column and row totals shown in the tables, however, are accurate". Use in purchasers' price has non-zero row of subsidies on products and valuation layer of taxes includes only taxes but no subsidies. This implies that the layer of subsidies should be estimated and added to the available use table.
Switzerland	Supply and use in producers' prices for 2008 in national currency (<u>ETH Zurich</u>)	Vector of total margins was missing from supply table. Valuation layers of total margins and net taxes were estimated based on EXIOPOL rates. Subsequently, use in purchasers' prices and in basic prices were calculated based on available use and estimated values. Vector of total margins was calculated based on corresponding estimation of valuation layer.
China	Input-output table in producers' prices for 2007 in national currency (<u>GTAP</u>)	See description after the table
Indonesia	For year 2005 in national currency: input-output table in purchasers' prices, total input-output table in producers' prices and domestic input-output table in producers' prices (<u>BADAN PUSAT STATISTIK</u>)	See description after the table

Countries	Available raw data	Notes
India	Use table in factor prices and product mix table for 2004 in national currency (CENTRAL STATISTICAL ORGANISATION)	See description after the table
Japan	Input-output table for 2005 in national currencies in the following valuations: total producers' prices, imported products, trade margins (2 types), transport margins (7 types) and purchasers' prices (http://www.stat.go.jp/english/index.htm)	See description after the table
South Korea	For year 2007 total, domestic and import input-output tables in producers' prices in national currency; for year 2005 input-output table in national currency in the following valuations: basic prices, producers' prices and purchasers' prices (Bank of Korea)	See description after the table
Mexico	For year 2003 in national currency: supply, use in purchasers' prices, total use in basic prices, use of domestic products in basic prices, use of imported products in basic prices, valuation layers of taxes, subsidies, trade margins and transport margins (National Institute for Statistics and Geography)	Data is taken from EXIOPOL raw files. Availability of more recent data was checked, but nothing was available
Norway	Supply and use in purchasers' prices till 2007 in national currency (Eurostat)	For valuation layers rates of Finland are taken as proxy
Russia	For year 2003 in national currency: supply, use in purchasers' prices, total use in basic prices, use of domestic products in basic prices, use of imported products in basic prices, valuation layers of net taxes, trade margins and transport margins (GKS)	Original tables have significant imbalances

Countries	Available raw data	Notes
Turkey	Supply and use in purchasers' prices for 2002 in national currency (Eurostat)	For valuation layers rates of Romania are taken as proxy
Taiwan	Input-output table for 2006 in national currency in the following valuations: total producers' prices (2 types: with and without import duties), domestic products, imported products (2 types: with and without import duties), trade margins (2 types), transport margins (7 types) and purchasers' prices (National statistics)	IO in purchasers' prices is taken as use table and supply was assumed diagonal. Since IO in producers' prices had non-zero row of product taxes it was assumed that this table can be taken as use in basic prices with exception that VAT and net import duties moved from the value-added block to the row 'Net taxes on products' (VA block in basic prices should be the same as in purchasers' prices). Valuation layer of net taxes was calculated as difference between use in purchasers' prices and sum of use in basic prices and total margins
United States	For year 2002 in national currency: supply, use in purchasers' prices, total use in basic prices, use of domestic products in basic prices, use of imported products in basic prices, valuation layers of taxes (2 types), subsidies, trade margins (2 types), transport margins (6 types)	Data is taken from EXIOPOL raw files. Availability of more recent data was checked, but nothing was available
South Africa	Supply and use in purchasers' prices for 2005 in national currency (Statistics South Africa)	For valuation layers rates of EXIOPOL are taken as proxy

China:

Since only an input-output table was available, it was taken as use table and supply was assumed diagonal. Original data was only available in producer's prices. Therefore the valuation layer of net taxes had to be estimated based on tax rates available from EXIOPOL. Then the table of net taxes was subtracted from the original data, the table in basic prices was the result. However, in some transactions the tax rates from EXIOPOL were too high (60-390%). These tax rates were replaced by the tax rate of a comparable transaction. This was the case for most transactions from the products Wholesale and retail trade. Also this was the case for the transactions: transport storage - petroleum processing and transport storage - GFCF. Valuation layer of total margins was estimated based on rates from EXIOPOL. Then the table of total margins was added to the original data, the table in purchasers' prices was the result. In the original table the vector of net taxes on products was missing, it was taken as a sum from net taxes valuation layer. Net

taxes on production (from value added block) were adjusted in such a way that all tables were in balance.

Indonesia:

Since only input-output tables are available, supply table was assumed to be diagonal and IO in purchasers' prices was taken as use in purchasers' prices. In IO in purchasers' prices only taxes (duty and sales) on imported products are given. Taxes on domestic output were estimated using rate on VAT (10%) for most products and zero rate for some specific products. Tax rates were applied only on value added for each product (possible to do since supply is diagonal). Zero tax rate was used for the following products: paddy, beans, maize, 'coal and metal ore mining', 'crude oil, natural gas and geothermal mining', 'other mining and quarrying', 'restaurant and hotel', railway, road, water and air transport, financial intermediaries, 'general government and defense', 'social and community services'. Rate of 9% was used for manufactured cigarettes. The rates were based on Indonesian Tax Guide 2010 from Deloitte. Application of other types of product taxes was very difficult because their rates could vary significantly between specific products within 65 products groups available in IO tables. Vector of total use in purchasers' prices was kept as in original tables and operational surplus in use table was used to keep balance between columns of supply and use tables. Valuation layer of total margins was calculated as IO in purchasers' prices minus IO in producers' prices. Small imbalances were removed using RAS procedure. Valuation layer of net taxes is based on EXIOPOL rates.

India:

In order to get supply table column totals from available use tables were distributed accordingly with the product mix table. Import vector was already given as part of use table. Factor prices were assumed to be similar to basic prices. Valuation layer of total margins was estimated based on EXIOPOL rates. From available use table net indirect taxes per industry were already known. In order to estimate the net taxes valuation layer initial guess was estimated based on EXIOPOL rates and further balanced using minimum entropy taken total taxes from use table as a constraint. For some industries the mathematical problem could not be solved (because of negatives) and the gross value added was adjusted in such a way that total industry output would remain unchanged. This occurred with the industries: paddy, wheat, gram, sugarcane, groundnut, coconut, tea, tobacco, other crops, milk and milk products, egg and poultry, other livestock products, electricity, railway transport services and communication.

Tax rates, calculated based on EXIOPOL, data were for some transactions extremely high (70-200%). To correct for this either the average of the product category was taken or, when this option would still not give an acceptable tax rate, the tax rates of a comparable product category was copied. In the list below the specifications are given:

- Product: Industrial machinery (others) - tax rates were copied from industrial machinery (F&T);
- Product: Other transport equipment - tax rates were copied from motor vehicles;
- Activity: Tea and coffee processing (col) - tax rates were copied from miscellaneous food products;
- Transactions: Industrial machinery (F&T) (row) & Tobacco manufacturing - average of product category was taken;
- Activity: Beverages manufacturing (col) - tax rates were copied from miscellaneous food products;

- Transactions: Organic heavy chemicals (row) & Computer related services - tax rates from product category were taken;
- Transactions: Organic heavy chemicals (row) & Plastic products - tax rates from product category were taken.

Japan:

In the original data each transaction is marked by one of the following types: standard input, scrap input, scrap output, by-product input, by-product output, trade margins, transport margins. Original input and output of scrap, as well as by-products, are balanced between each other. The products which had scrap input/output transactions were split into two types: virgin and recycled. Firstly use table was estimated using following assumptions:

- Intermediate block: standard input + scrap input + scrap output;
- Value added block: standard input;
- Final demand block: standard input + scrap input + scrap output + by-product input (since scrap output should be added with minus sign some of the final demand entries are negative, e.g. used paper, recycled glass product, etc.).

In the IO table only commodity taxes and duties on imported product were given. In order to estimate taxes on domestic products the tax rate of commodity taxes on imported products were use with the following exceptions:

- 5% rate for the products where import rate was not available (5% is an estimate of average commodity tax rate);
- Zero rate on certain products and public services: pork (bone meat), school lunch, private power generation, waste management services, self-transportation by private cars, airport and traffic control, public administration, school education, social education, research institutes, health and hygiene, social insurance, social welfare, office supplies;
- Zero rate on recycled products.

In order to estimate intermediate part of the supply table, total domestic output per product was calculated as total use in purchasers' prices minus total margins minus total product taxes and minus imports. Then scrap output and by-product output were placed in the intermediate part and all the rest domestic output were put on the diagonal.

Since additional taxes on commodities were estimated, operating surplus in use table was used to keep balance between columns of supply and use tables. Valuation layer of net taxes is based on EXIOPOL rates.

South Korea:

Since only input-output table was available, it was taken as use table and supply was assumed diagonal.

The problem with using original IO table for 2007 was that certain products had negatives due positive output of scraped materials during production process. The table for 2005 had the following properties:

- Purchasers' prices: no negatives, because output of scraped materials is given in a separate row and total use of scraped materials is given in a separate column;
- Producers' prices: negatives due positive output of scraped materials during production process; negatives are only in total and domestic tables, import table was without scrap;

- Basic prices: negatives due positive output of scraped materials during production process. Value added differs from other valuations. Probably this adjustment by the value of net taxes on products was made by the statistical office in order to keep row-column balance (in purchasers' and producers' prices there are only columns with commodity taxes on imported products).

Firstly, valuation layer of total margins for year 2005 and output of scraped materials by each production activity for year 2005 were estimated using minimum entropy problem. Restrictions used in the estimation:

- Total margins + scrap output = IO in purchasers' prices - IO in producers' prices;
- Each column of margins sums up to zero (positives and negatives are allowed only in specific places);
- Each row of margins sums up to the corresponding value from IO in purchasers' prices;
- Each column of scrap output sums up to the scrap output from IO in purchasers' prices;
- Each row of scrap output sums up to the scrap input from IO in purchasers' prices;

Secondly, IO in producers' prices for year 2005 without negatives was calculated as a difference between IO in purchasers' prices and estimated valuation layer of total margins. Thirdly, scrap output for year 2007 was estimated using the assumption that it equals a certain share of total intermediate inputs. Shares were assumed the same as in year 2005. Scrap output of dummy sector row was set to zero. Next, total scrap was distributed between users. It was assumed that the total amount of a certain scraped material is used only by one sector. This sector was defined as a maximum user or taken the same as in Japan data. Next, IO in producers' prices for year 2007 without negatives (in intermediate part) was calculated as a sum of original IO in producers' prices and scrap output. All input of scraped products was put into new product 'Recycled materials'. Negatives in final consumption reflect output of recycled materials by households and GFCF (this output cannot be put into supply table). Next, valuation layer of total margins for year 2007 was estimated using the margins rates from year 2005. The table was balanced to sum up to zero using the minimum entropy problem approach. Next, IO in purchasers' prices for year 2007 without negatives (in intermediate part) is calculated as a sum of IO in producers' price without negatives and estimated valuation layer of total margins. Next, net taxes on products for year 2007 are estimated using the tax rates from year 2005. For year 2005 net taxes valuation layer is calculated as IO in producers' prices - IO in basic prices. Next, IO in basic prices for year 2007 without negatives (in intermediate part) is calculated as a difference between IO in producers' price without negatives and estimated net taxes. Value added decreased (through taxes on production) by the amount on net taxes on products in order to keep row-column balance. Next, domestic IO in producers' prices for year 2007 is calculated as difference between IO in producers' prices without negatives and original import IO in producers' prices. Supply table was estimated at the last step with total values on diagonal and all output of scraped materials put into new product 'Recycled materials'. Column of other net taxes on products includes net taxes on domestic products and was calculated as difference between total net taxes from corresponding valuation layer and taxes on imported products (custom duties plus commodity taxes).

3.2 Auxiliary Data

3.2.1 Agriculture Social Accounting Matrices for European Countries (AgroSAM)

A set of Social Accounting Matrices for the EU27 were developed as part of the AgroSAM project at the Institute for Prospective Technological Studies (Müller, Pérez Domínguez et al. 2009). These tables follow the standard Eurostat format of supply use tables in purchaser prices, but extended for feedbacks of primary inputs into final demand (not used in this project). In addition, the project provided disaggregated agricultural data for 30 primary agricultural sectors and 11 food processing sectors. Such detail allowed the direct mapping of the AgroSAM database to the EXIOBASE classification for all sectors except one – this being processing of fish products which was aggregated with food products nec. As the AgroSAM data is only for 2000, the structure of inputs and sales were taken for the agricultural and food sectors, and applied as coefficients to the disaggregation of the 2007 tables.

3.2.2 Agricultural outputs

FAOSTAT data was used for estimates of production values in 2007 dollars for the agricultural sector directly. This output data was coupled with the AgroSAM data on coefficients. Some adjustments were made to FAOSTAT data where there was a discrepancy between non-zero physical reported values and zero monetary reported values. Export prices were applied to the domestic physical production as a proxy.

3.2.3 PRODCOM

Manufacturing output for European countries is obtained from the PRODCOM database (Eurostat 2012a). Whilst this database is highly detailed, it often does not cover small producers and contains quite some confidential information. As a result, a number of quality checks were introduced in order to filter out suspect data. These checks included cross-checking to export data (if domestic production added up to more than exports), checking endogenous prices, checking the scaling of a product group to the aggregate MSUT data. If large discrepancies were found, the data was disregarded.

3.2.4 Energy Products

The IEA Energy Balances was used as the source of disaggregation for the energy sectors (International Energy Agency 2012a). Energy data was mapped to specific EXIOBASE sectors with prices applied (see below).

3.2.4.1 Electricity – distribution and transmission

In order to be able to disaggregate the electricity costs the data sheets have been filled with information for industry and households, respectively, stemming from work done in EXIOPOL reconciled to Eurostat statistics for the EU (Eurostat 2012b). The data have been made comparable by transforming them into a common unit, i.e. Euros/MWh. Some countries report the relative proportion of distribution and transmission (Australia and Canada) in the SUTs, and these values were confronted with aggregate country specific data where available. Similar treatment was done for distribution of Natural Gas.

3.2.4.2 Energy – price information

For most carriers/products the data are directly taken from the IEA source (in \$ per toe) (International Energy Agency 2012b). These data pertain only to selected OECD countries. As for non-OECD countries covered by the IEA, the data are calculated using the original price data (\$ per Unit) and suitable conversion factors (toe per Unit). For some carriers/products prices per unit of calorific content are not provided by the IEA, so they are calculated even for OECD countries.

For every product the missing data for a country was calculated using the average product price of other countries from the same geographical region. We distinguish between seven regions:

1. Austria, Belgium, Denmark, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Switzerland, UK
2. Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovak Republic
3. Finland, Sweden, Norway
4. Bulgaria, Cyprus, Greece, Malta, Romania, Slovenia, Turkey
5. China, India, Indonesia
6. Korea, Taiwan
7. Brazil, Canada, Mexico, USA.

Prices for Japan were usually too high and apparently independent from other Asian countries, so it wasn't assigned to any region. Because of geographic uncertainty Australia, Russia and South Africa weren't assigned as well. For these countries, as well as the RoW, the average price of already determined prices was taken.

4 MSUT Data Harmonisation

4.1 SUT Pre-processing

The first stage in the SUT harmonisation and detailing regards the inventory and quality check of original aggregate SUT data. In essence this implies gathering:

- For EU27: ESA95 tables discerning 59 sectors and products
- For the 16 non EU countries: SUT and/or IOT in all kinds of classifications

SUT data is not always consistent across countries, and need adjustment for the MRIO context. Tables can be found that show negative values at unexpected places, are not properly balanced, etc. Hence as a first stage of the data harmonization concordances of classification are prepared and cursory checks on validity of data us performed. Secondly, the consistency of the data is checked and detected errors in original tables are corrected. Harmonization across different accounting conventions is done in this step. Key aspects include the treatment of FISIM; the handling of purchasers by residents abroad; the handling of purchases on the domestic territory by non-residents; the conversion or estimation of data to enable the estimation of basic price tables (price harmonization); the preliminary balancing of tables; and the re-basing of tables to a common base year. The final files are exported as cleaned files. An automated approach allows for creating datasets for multiple years and easy update of the data in the future.

4.1.1 Purchasers by residents abroad; Purchases on the domestic territory by non-residents

As we follow the residential principle in the construction of MRIO tables, purchasers abroad must be treated as imports, and purchases on the domestic territory by non-residents are treated as exports. As most countries only report total purchasers abroad and non-resident purchasers, these must be allocated to product type. The allocation is done in a two-step process to estimate a representative import mix of households from the aggregate purchaser prices SUT data:

- 1) proportionally allocating imports vector across different uses to give a crude estimate of imports by households, then
- 2) using this estimate to re-allocate the purchasers abroad.

Check	Description	Comments
1	Total industry output = intermediate block + value added	Accounting
2	Total product supply = total product use	Accounting
3	Total product supply = domestic supply + imports	Accounting
4	Sum over rows of taxes=taxes in use table	Accounting
5	Sum over columns of taxes =taxes in supply table	Accounting
6	Sum over columns of margins=margins in supply table	Accounting
7	Sum over rows of margins =0	Accounting
8	Sum over columns of imports= imports in supply table	Accounting
9	Industry Supply check (% on diagonal)	Defined as <i>potential problem</i> if any value < 40% as this means the reference product of the industry is not correct.
10	Negatives in wrong place	Check on Supply and Use table for negative values where positive only allowable (e.g. intermediate inputs, final consumption, gross fixed capital formation)
11	Margins do not exist	Check on tables for existence of all margins (all types of trade and transport)
12	Aggregation of data	Check if any (original) ESA95 Supply Use IO table includes aggregated data for any industry/product
13	FISIM (Financial Intermediation Services Indirectly Measured)	Check on need for re-allocation of FISIM
14	Zero main product from the industry	Zero own production i.e. zero diagonal supply. This may indicate classification problem.
15	Negative value added	The sum of intermediate inputs is greater than total output. (Indication of coefficients >0)
16	Other net taxes on production are missing from value added	
17	Confidentiality	Highlight countries with confidential data in tables
18	Taxes and subsidies cannot be reconciled	Taxes less subsidies row cannot be disaggregated given purchaser price table and Taxes less subsidies column
19	Margins cannot be reconciled	Margins column cannot be disaggregated given purchaser price table.

Table 4.1: List of checks applied to SUTs in aggregate and disaggregate form

4.2 Disaggregating product and industry totals

Because of the changing classifications of individual countries, and because of the changing data availability for each country, product and industry totals were generated for each country that respect the aggregate SUT totals, but that embody as much auxiliary data as possible.

As product totals detail is higher than industry detail, product detail is generated first. Most auxiliary data is in the form of products as well. The basic order of usage of auxiliary is given in table 4.2:

Order	Dataset Name
1	Selected mining and mineral data*price
2	FAO Monetary data
3	PRODCOM, Quality checked data
4	IEA energy balance data*energy prices
5	Structural Business Statistics (SBS) of Eurostat
6	Trade data (BACI)
7	Zero price assumptions on waste flows
8	Representative country data

Table 4.2: Basic order of usage of auxiliary data.

The full list of final data used for each product is listed in the appendix. A recursive routine was utilized to add detail to the aggregate classification so that if, for example, the SBS data gave higher quality data on a two sub-groups of products (e.g. electricity generation and transmission/distribution) then the SBS data would be used to do a first split before IEA or other data is used to split the electricity generators individually.

Industry total disaggregation is done in the same method as per product total disaggregation, but utilizing different datasets (Table 4.3). Further, where industry specific data is not available, the product totals are used to give shares to the industry totals. As a final check for consistency, where industry totals derived from UNIDO and SBS data does not reasonably well match estimated product totals (+/-50% to account for off-diagonal supply) the UNIDO/SBS data is ignored. As SBS data is for a more restricted set of industries, and as it is also used to inform product disaggregation, in reality, this mainly means leaving out use of UNIDO data, which is known to be somewhat incomplete.

Order	Dataset Name
1	UNIDO
2	Structural Business Statistics (SBS) of Eurostat
3	Product total estimates

Table 4.3: Basic order of industry total disaggregation.

4.3 Generation of ideal coefficients

To complement the product and industry outputs, a set of ideal coefficients are constructed in the final classification of EXIOBASE from a range of sources. The coefficients are the expected technology employed in each industry, and are used only to give resolution below the aggregate supply and use tables. Both Supply and Use ideal coefficients are generated, in order to capture the occurrences of by-production and joint-production.

The source of the ideal coefficients is mainly the most disaggregated IOTs. This is then complemented with specific coefficient data for the electricity sectors, energy products, agricultural products, and a range of cross-checks and refinements in order to ensure that the coefficient set is reasonably unbiased. The summary of IOTs used in the ideal coefficients is given in table 4.4.

Country	Product detail	Sector detail	Year	Availability	Notes
Japan	>500	>400	2005	online ¹	Very good
US	429	426	2002	Used in Exiopol	No IOT, only SUTs. Not so good, new table will be released probably in 2012 for 2007, high level of detail on services
Canada	322	129	2000	Used in Exiopol	
Australia	123	111	2007-2008	online ²	Not so much detail

Table 4.4: IOTs used in the ideal coefficients

Additional detail was included for the electricity sector using GEM-E3³; for the aluminium sector using industry data⁴; for natural and manufactured gas from the detailed Australian SUTs (Australian Bureau of Statistics 2012). Coefficients for some agriculture, some energy and some manufacturing flows were taken from WP4 (physical LCI coefficients multiplied by prices).

4.4 Generation of country specific coefficients

Country specific coefficients were generated from the ideal coefficients in order to capture the potential substitution of energy carriers, and the joint production in the use-coefficients. As such, supply coefficients were reconciled to the aggregate MSUT supply table to provide a first estimate of country specific joint production. In the end, for reasons of expediency, for the intermediate block:

- For originally diagonal elements off-diagonals distribution weight are set to zero and diagonal ones are based on total output of a specific activity.

¹ <http://www.e-stat.go.jp/SG1/estat/ListE.do?bid=000001019588&cycode=0>

² <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/5209.0.55.0012007-08%20Preliminary?OpenDocument>

³ http://www.ecmodels.eu/index_files/MODELS%20Description%20of%20GEM-E3%20Developments.pdf

⁴ <http://agmetminer.com/2009/02/27/cost-build-up-model-for-primary-aluminum-ingot-production/>

- For originally off-diagonal elements distribution weights are based on multiplication of share of total output of a specific activity and of a specific product.

The market shares were then multiplied by the product-specific use coefficients in order to get country specific use coefficients for each industry.

4.5 MSUTs disaggregation approach

4.5.1 Estimation of updated 'initial estimate' of disaggregated supply and use in purchasers' prices tables

The first step to disaggregated and balanced system of supply and use tables (big tables) is to estimate their draft versions based on original tables (aggregate tables) and auxiliary data (Fig 4.1). The 'initial estimates' are estimated in such a way that their aggregation yields back original aggregate tables. Using a schematic example we can see that three types of disaggregation will be present: from cell to row-vector (blue), from cell to column-vector (green) and from cell to matrix (yellow). We use auxiliary data to get relative distribution weights for each of the orange cells. Distribution weights are set in such a way that the sum of three blue cells in the first row equals orange cell in the first row and so on. The grey cells remain as in the small original table.

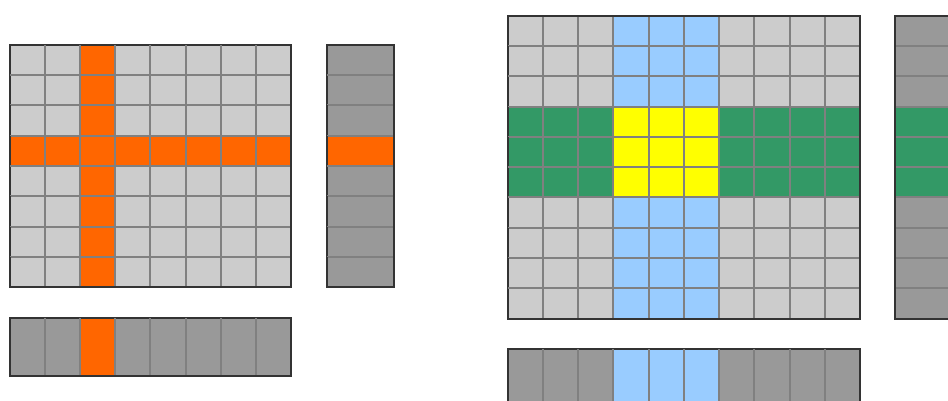


Fig 4.1: Left: Original aggregate table; Right: Draft big table

We start with estimation of 'initial estimates' for supply table and use table in purchasers' prices. Disaggregation of use table is a more difficult task and is based on the following auxiliary data:

- Intermediate block:
 - For detailed agricultural and food products and activities distribution weights are based on Social Accounting Matrices with detailed representation of agriculture and food. SAMs are available only for EU-27 countries.
 - For detailed energy products distribution weights are based on energy balances of International Energy Agency which were converted into monetary values.
 - For all other activities and products distribution weights are based on combination of 'ideal monetary coefficients' and total output of a specific activity⁵.
- Value added block: distribution weights are based on total output of a specific activity. In case if the original tables don't have enough details about value added components, shares from the table of 'ideal monetary coefficients' are used.
- Final demand block:
 - For final consumption distribution shares are based on data from AgriSAMs or energy balances, if possible. For other products shares from the table of 'ideal monetary coefficients' are used.
 - For changes in inventories distribution shares are based on data from energy balances, if possible. For other products shares of domestic production are used.
 - For export column distribution shares are based on corrected BACI trade data. BACI data were corrected for energy products in order to be able to preserve global energy balance.

Disaggregation of supply table is based on the following auxiliary data:

- Country specific supply coefficients for all flows except agricultural flows from AgriSAMs.
- Import: distribution shares are based on corrected BACI trade data. BACI data were corrected for energy products in order to be able to preserve global energy balance.
- Valuation block: distribution shares are based on data from AgriSAMs, if possible. For other products total supply in basic prices are used.

⁵ Data on total output are collected from various sources, including among others Structural Business Statistics, PRODCOM, Geological Surveys, FAO.

Balancing supply and use in purchasers' prices tables

After the first step we have two tables of 'initial estimates': supply in basic prices with valuation into purchasers' prices - S - and use table in purchasers' prices - U . Although the tables are in line with the original official statistical tables and preserve the structure from auxiliary data, the tables in general case would not be mutually balanced. In order to balance the system the following nonlinear problem is solved.

Tables' notation:

S, U - 'first guess' versions of disaggregated supply and use tables;

$\tilde{S}, \tilde{U}$ - mutually balanced supply and use tables (target tables).

The target tables are obtained by minimizing the distance between the draft tables and the balanced ones. Distance is approximated by the entropy function which reads:

$$e \equiv \sum_{i,j} |s_{ij}| \cdot \ln \left(\frac{s_{ij}}{\tilde{s}_{ij}} \right) + \sum_{i,j} |u_{ij}| \cdot \ln \left(\frac{u_{ij}}{\tilde{u}_{ij}} \right) \xrightarrow{\tilde{u}_{ij} \tilde{s}_{ij}} \min ,$$

where the lowercase symbols are elements of the tables denoted with corresponding capital symbols.

The optimization problem is being solved subject a number of constraints:

1. Total supply equals total use: $\sum_j \tilde{s}_{ij} = \sum_j \tilde{u}_{ij}, \forall i$.
2. Total output equals intermediate consumption plus value added: $\sum_i \tilde{s}_{ij} = \sum_i \tilde{u}_{ij}, \forall j$.
3. Total output is close to total output derived from auxiliary data:
 $\sum_i \tilde{s}_{ij} = slack_j \cdot output_j, \forall j$. In most of the cases the $slack_j$ variable is kept within the range $[0.9, 1.1]$. Positive, negative and zero values are placed correctly:
 $sgn(\tilde{s}_{ij}) = sgn(s_{ij})$ and $sgn(\tilde{u}_{ij}) = sgn(u_{ij}), \forall i, j$.
4. Aggregation of $\tilde{S}$ and $\tilde{U}$ yields original small tables.

Estimation of valuation matrices and use table in basic prices

Based on information about taxes and subsidies on products and trade and transport margins for a specific country, a similar country, or from previous work within EXIOPOL project, the following steps are taken to obtain valuation layers and use table in basic prices:

1. 'Initial estimate' of net taxes table is calculated based on the structure of the total use table in purchasers' prices $\tilde{U}$, variation of net tax rates between different users (same country, similar country or EXIOPOL rates) and taking the vector of total net taxes from the supply table $\tilde{S}$ as a constraint.
2. 'Initial estimates' of trade and transport margins tables separately are compiled in three sub-steps. Firstly, total positive margin values are estimated based on the structure of the total use table in purchasers' prices $\tilde{U}$, variation of total margin rates between different users (same country, similar country or EXIOPOL rates) and taking the vector of total margins from the supply table $\tilde{S}$ as a constraint. Secondly, negative margin values are distributed column-wise using structure of margins in supply table $\tilde{S}$. And lastly the total margins table is split into separate trade and transport margins tables using proportions of trade products' and transport products' margins.
3. Final estimates of valuation matrices and use table in basic prices are derived using another balancing procedure. As in the case with supply and use in purchasers' prices tables the distance approximated by the entropy function

between the 'initial estimates' and balanced table is minimized. The following constraints are used during the optimization procedure:

- a. Total taxes and total margins per product equal to the corresponding columns from the supply table S .
- b. Total margins per user are equal to zero.
- c. The use table in basic prices, derived as use table in purchasers' prices minus net taxes and minus margins, has negative values only in the same positions as the use table in purchasers' prices U .
- d. Per user the absolute value of a negative margin cannot be greater than the sum of positive margins on products corresponding to this negative margins. For example, margins charged by retail trade services of motor fuel cannot be greater than the margins included in the purchasers' price of motor fuel products. This constraint is included in order to assure that margins charged always correspond to a physical transaction of product.

Estimation of domestic and import use tables in basic prices

There are several ways to estimate import use tables. In case of no other import information available, the imports are distributed row-wise using the vector of total import in the supply table S and structure of total use table in basic prices.

The other option is to calculate percentage of import in each transaction from small original import and domestic use tables and apply this percentage to corresponding cells in total use table in basic price. After that each row should be adjusted so it sums up to the corresponding import value in the supply table S .

Domestic use table is calculated as a difference between total use table in basic prices and import use table.

5 Trade data and trade linking

The main trade data used in CREEA originates from the UN Comtrade database (United Nations Statistics Division 2012a) and the UN services trade database (United Nations Statistics Division 2012b). The Comtrade data whilst of reasonably high quality is not reconciled to itself, such that bilateral exports are not consistent with the mirror of bilateral imports. The BACI database (Gaulier and Zignago 2010) is based on UN Comtrade, but is reconciled, such that for a single year, every trade flow is recorded as a single bilateral trade flow in both physical units and in f.o.b. monetary valuation.

We hence start with the BACI database in both physical and monetary values and aggregate the 5000 or so products of the HS classification into the EXIOBASE2.0 classification. Whilst this is usually a simple aggregation, for energy and waste flows, the EXIOBASE 2.0 classification is more detailed than the HS classification such that disaggregation is also required. Estimated energy exports (from the IEA database) or else estimated domestic production is used to disaggregate these HS codes. A similar process is done for the UN services trade database. The services trade database is complicated by much missing data, the multiple levels of aggregation and the partial reporting of bilateral trade flows, and total import/export flows. A bottom-up process is used to utilise as much information as possible in maintaining detailed product and bilateral flows scaled to aggregate product and total import/export flows. Where the product detail is not high enough in the services trade data, the export flows are split by the shares of domestic production.

Once the bilateral commodity trade and services trade data is in the EXIOBASE2.0 classification, it then undergoes a number of pre-processing steps in order to match it to both IEA energy data and MSUT trade data (Fig. 5.1). In the first step, the bilateral trade data is reconciled to the total IEA imports and exports by country and product using mathematical programming. In a second step, the bilateral trade data is then reconciled to MSUT aggregate imports (CIF valuation) and exports (FOB) using the bilateral trade data and an estimate of margins. This provides a complete bilateral trade dataset that can then be used for estimation of the RoW and are close to final data points in the MSUT disaggregation.

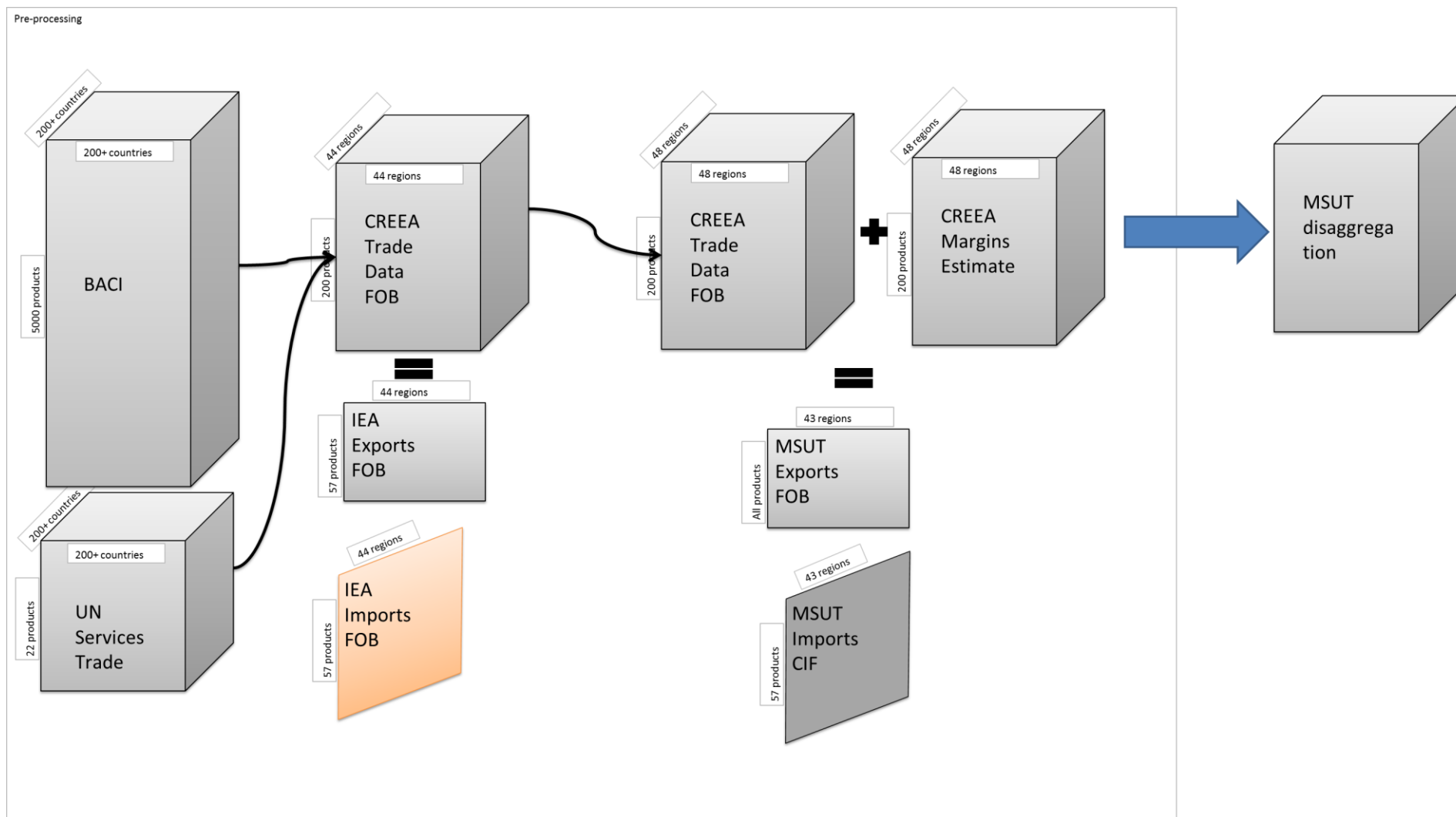


Figure 5.1 Trade pre-processing before estimation of MSUT values

6 Rest of the World

6.1 Material and Methods

The first step in building Rest of the World (RoW) Supply Use Tables (SUTs) was to estimate the RoW gross domestic product (GDP) per region (in USD, Fig. 6.1 gives an overview of the whole estimation procedure). These estimates were based on the GDP data from the The World Bank (<http://www.worldbank.org/> - GDP in current US\$ purchaser's prices).

$$\begin{aligned}\text{GDP(RoW)} &= \text{GDP(world)} - \text{sum}(\text{GDP(CREEA countries)}) \\ \text{GDP(RoW)} &= \text{sum}(\text{RoW countries})\end{aligned}$$

The two approaches to estimate the GDP of the RoW resulted in minor differences: according to the first calculation the GDP of the RoW was 6.14E+12 USD versus 6.08E+12 USD for the second approach. To compensate for the differences, we scaled the GDP of the RoW countries to add up to the RoW estimated with formula 1. Subsequently the RoW countries were grouped into five regions (RoW Asia and Pacific, RoW Europe, RoW Middle East, RoW Africa, RoW America, see Table 6.1). For the RoW Middle East region we followed a traditional definition of this region (https://en.wikipedia.org/wiki/Middle_east).

In the next step we collected gross industry output and value added per broad industry sector from the UNdata (<https://data.un.org/>) National Accounts Official Country data ('Table 2.3 Output, gross value added, and fixed assets by industries at current prices'). For every country disaggregated sectors were deleted in case of major discrepancies (>20% between the sum of individual entries and the aggregated value) and re-disaggregated based on the average share obtained from the remaining countries.

Final demand data per category were collected from the UNdata ('Table 1.1 Gross domestic product by expenditures at current prices') and also revised in case of major discrepancies.

Values in both UN databases provide values in local currency. These were converted to USD by the exchange rate derived from:

$$\text{GDP(USD)}/\text{GDP(local currency)}$$

Industry output and final demand data were then summed per region. Due to missing country in the UNdata, the sum of the GDP per region derived from them did not add up to the GDP per region derived from the Worldbank. Therefore, we scaled all entries from the region aggregation with:

$$\text{GDP(USD, region WB)}/\text{GDP(USD, region UN)}$$

Disaggregated values in the resulting table were scaled such that all values add up to the next aggregate.

Table 6.1: RoW countries and classification

ISO3	Country	Region CREEA	Region CREEA name
AFG	Afghanistan	WA	RoW Asia and Pacific
ALB	Albania	WE	RoW Europe
DZA	Algeria	WF	RoW Africa
AND	Andorra	WE	RoW Europe
AGO	Angola	WF	RoW Africa
ATG	Antigua and Barbuda	WL	RoW America
ARG	Argentina	WL	RoW America
ARM	Armenia	WA	RoW Asia and Pacific
AZE	Azerbaijan	WA	RoW Asia and Pacific
BHS	Bahamas, The	WL	RoW America
BHR	Bahrain	WM	RoW Middle East
BGD	Bangladesh	WA	RoW Asia and Pacific
BRB	Barbados	WL	RoW America
BLR	Belarus	WE	RoW Europe
BLZ	Belize	WL	RoW America
BEN	Benin	WF	RoW Africa
BMU	Bermuda	WL	RoW America
BTN	Bhutan	WA	RoW Asia and Pacific
BOL	Bolivia	WL	RoW America
BIH	Bosnia and Herzegovina	WE	RoW Europe
BWA	Botswana	WF	RoW Africa
BRN	Brunei Darussalam	WA	RoW Asia and Pacific
BFA	Burkina Faso	WF	RoW Africa
BDI	Burundi	WF	RoW Africa
KHM	Cambodia	WA	RoW Asia and Pacific
CMR	Cameroon	WF	RoW Africa
CPV	Cape Verde	WF	RoW Africa
CAF	Central African Republic	WF	RoW Africa
TCD	Chad	WF	RoW Africa
CHI	Channel Islands	WE	RoW Europe
CHL	Chile	WL	RoW America
COL	Colombia	WL	RoW America
COM	Comoros	WF	RoW Africa
COD	Congo, Dem. Rep.	WF	RoW Africa
COG	Congo, Rep.	WF	RoW Africa
CRI	Costa Rica	WL	RoW America
CIV	Cote d'Ivoire	WF	RoW Africa
HRV	Croatia	WE	RoW Europe
CUB	Cuba	WL	RoW America
DJI	Djibouti	WF	RoW Africa
DMA	Dominica	WL	RoW America
DOM	Dominican Republic	WL	RoW America

Table 6.2 (continued): RoW countries and classification

ISO3	Country	Region CREEA	Region CREEA name
ECU	Ecuador	WL	RoW America
EGY	Egypt, Arab Rep.	WM	RoW Middle East
SLV	El Salvador	WL	RoW America
GNQ	Equatorial Guinea	WF	RoW Africa
ERI	Eritrea	WF	RoW Africa
ETH	Ethiopia	WF	RoW Africa
FRO	Faeroe Islands	WE	RoW Europe
FJI	Fiji	WP	RoW Asia and Pacific
GAB	Gabon	WF	RoW Africa
GMB	Gambia, The	WF	RoW Africa
GEO	Georgia	WA	RoW Asia and Pacific
GHA	Ghana	WF	RoW Africa
GRL	Greenland	WL	RoW America
GRD	Grenada	WL	RoW America
GTM	Guatemala	WL	RoW America
GIN	Guinea	WF	RoW Africa
GNB	Guinea-Bissau	WF	RoW Africa
GUY	Guyana	WL	RoW America
HTI	Haiti	WL	RoW America
HND	Honduras	WL	RoW America
HKG	Hong Kong SAR, China	WA	RoW Asia and Pacific
ISL	Iceland	WE	RoW Europe
IRN	Iran, Islamic Rep.	WM	RoW Middle East
IRQ	Iraq	WM	RoW Middle East
IMY	Isle of Man	WE	RoW Europe
ISR	Israel	WM	RoW Middle East
JAM	Jamaica	WL	RoW America
JOR	Jordan	WM	RoW Middle East
KAZ	Kazakhstan	WA	RoW Asia and Pacific
KEN	Kenya	WF	RoW Africa
KIR	Kiribati	WP	RoW Asia and Pacific
KSV	Kosovo	WE	RoW Europe
KWT	Kuwait	WM	RoW Middle East
KGZ	Kyrgyz Republic	WA	RoW Asia and Pacific
LAO	Lao PDR	WA	RoW Asia and Pacific
LBN	Lebanon	WM	RoW Middle East
LSO	Lesotho	WF	RoW Africa
LBR	Liberia	WF	RoW Africa
LBY	Libya	WF	RoW Africa
LIE	Liechtenstein	WE	RoW Europe
MAC	Macao SAR, China	WA	RoW Asia and Pacific
MKD	Macedonia, FYR	WE	RoW Europe

Table 6.3 (continued): RoW countries and classification

ISO3	Country	Region CREEA	Region CREEA name
MDG	Madagascar	WF	RoW Africa
MWI	Malawi	WF	RoW Africa
MYS	Malaysia	WA	RoW Asia and Pacific
MDV	Maldives	WA	RoW Asia and Pacific
MLI	Mali	WF	RoW Africa
MHL	Marshall Islands	WP	RoW Asia and Pacific
MRT	Mauritania	WF	RoW Africa
MUS	Mauritius	WF	RoW Africa
FSM	Micronesia, Fed. Sts.	WP	RoW Asia and Pacific
MDA	Moldova	WE	RoW Europe
MCO	Monaco	WE	RoW Europe
MNG	Mongolia	WA	RoW Asia and Pacific
MNE	Montenegro	WE	RoW Europe
MAR	Morocco	WF	RoW Africa
MOZ	Mozambique	WF	RoW Africa
NAM	Namibia	WF	RoW Africa
NPL	Nepal	WA	RoW Asia and Pacific
NZL	New Zealand	WP	RoW Asia and Pacific
NIC	Nicaragua	WL	RoW America
NER	Niger	WF	RoW Africa
NGA	Nigeria	WF	RoW Africa
OMN	Oman	WM	RoW Middle East
PAK	Pakistan	WA	RoW Asia and Pacific
PLW	Palau	WP	RoW Asia and Pacific
PAN	Panama	WL	RoW America
PNG	Papua New Guinea	WP	RoW Asia and Pacific
PRY	Paraguay	WL	RoW America
PER	Peru	WL	RoW America
PHL	Philippines	WA	RoW Asia and Pacific
PRI	Puerto Rico	WL	RoW America
QAT	Qatar	WM	RoW Middle East
RWA	Rwanda	WF	RoW Africa
WSM	Samoa	WP	RoW Asia and Pacific
SMR	San Marino	WE	RoW Europe
STP	Sao Tome and Principe	WF	RoW Africa
SAU	Saudi Arabia	WM	RoW Middle East
SEN	Senegal	WF	RoW Africa
SRB	Serbia	WE	RoW Europe
SYC	Seychelles	WF	RoW Africa
SLE	Sierra Leone	WF	RoW Africa
SGP	Singapore	WA	RoW Asia and Pacific
SLB	Solomon Islands	WP	RoW Asia and Pacific

Table 6.4 (continued): RoW countries and classification

ISO3	Country	Region CREEA	Region CREEA name
LKA	Sri Lanka	WA	RoW Asia and Pacific
KNA	St. Kitts and Nevis	WL	RoW America
LCA	St. Lucia	WL	RoW America
VCT	St. Vincent and the Grenadines	WL	RoW America
SDN	Sudan	WF	RoW Africa
SUR	Suriname	WL	RoW America
SWZ	Swaziland	WF	RoW Africa
SYR	Syrian Arab Republic	WM	RoW Middle East
TJK	Tajikistan	WA	RoW Asia and Pacific
TZA	Tanzania	WF	RoW Africa
THA	Thailand	WA	RoW Asia and Pacific
TMP	Timor-Leste	WA	RoW Asia and Pacific
TGO	Togo	WF	RoW Africa
TON	Tonga	WP	RoW Asia and Pacific
TTO	Trinidad and Tobago	WL	RoW America
TUN	Tunisia	WF	RoW Africa
TKM	Turkmenistan	WA	RoW Asia and Pacific
TUV	Tuvalu	WP	RoW Asia and Pacific
UGA	Uganda	WF	RoW Africa
UKR	Ukraine	WE	RoW Europe
ARE	United Arab Emirates	WM	RoW Middle East
URY	Uruguay	WL	RoW America
UZB	Uzbekistan	WA	RoW Asia and Pacific
VUT	Vanuatu	WP	RoW Asia and Pacific
VEN	Venezuela, RB	WL	RoW America
VNM	Vietnam	WA	RoW Asia and Pacific
YEM	Yemen, Rep.	WM	RoW Middle East
ZMB	Zambia	WF	RoW Africa
ZWE	Zimbabwe	WF	RoW Africa

Average weighted shares for the disaggregation of the broad industry sectors of the UN database to the CREEA classification were obtained by aggregating sample country industry output to the UN broad sectors. The sample countries consisted of CREEA countries within the specific RoW region or of the world sum in case of too few country data (Table 6.2).

Region	Industry Output Disaggregation Sample
RoW Asia and Pacific	All Asian countries within CREEA (Japan, China, South Korea, India, Taiwan, Indonesia)
RoW America	All American countries (USA, Canada, Brazil, Mexico)
RoW Europe	All European countries within CREEA
RoW Africa	All CREEA countries
RoW Middle East	All CREEA countries

Table 6.2: Sample countries for the disaggregation of the broad industry output of the UNdata to the CREEA classification.

Energy related industry output per broad industry output as provided by the UNdata were redistributed based on shares obtained from the IEA data (see Section 3.2.4).

In the next step, preliminary product output was calculated using the ideal supply coefficient (see section 4.3). Region specific SUT coefficients were then constructed based on ideal coefficient tables which were reconciled for (a) the estimated product and industry output (b) joint production (c) region specific energy use.

To obtain a consistent trade link between the RoW regions and the other CREEA countries, imports and exports were exchanged by the estimates obtained the trade balancing routine (see section 5).

At this point, a fully disaggregated SUT for every RoW region existed. As these tables were derived based on different sources, the systems is most likely unbalanced.

We used a mathematical programming approach as per the individual country MSUTs to balance the system with minimized information gain. The objective value was calculated by weighted squared differences between the initial and calculated table. Weights were defined as reciprocal values of the initial table entries for values larger than 1E-3 or otherwise set to 1000. For every region, imports and exports as well as overall GDP and industry output were set as constrains.

The final tables were converted from USD to Euros with a conversion factor of 1.3704 (Eurostat 2012c). Finally, domestic and imported use was calculated by the share of import to total supply.

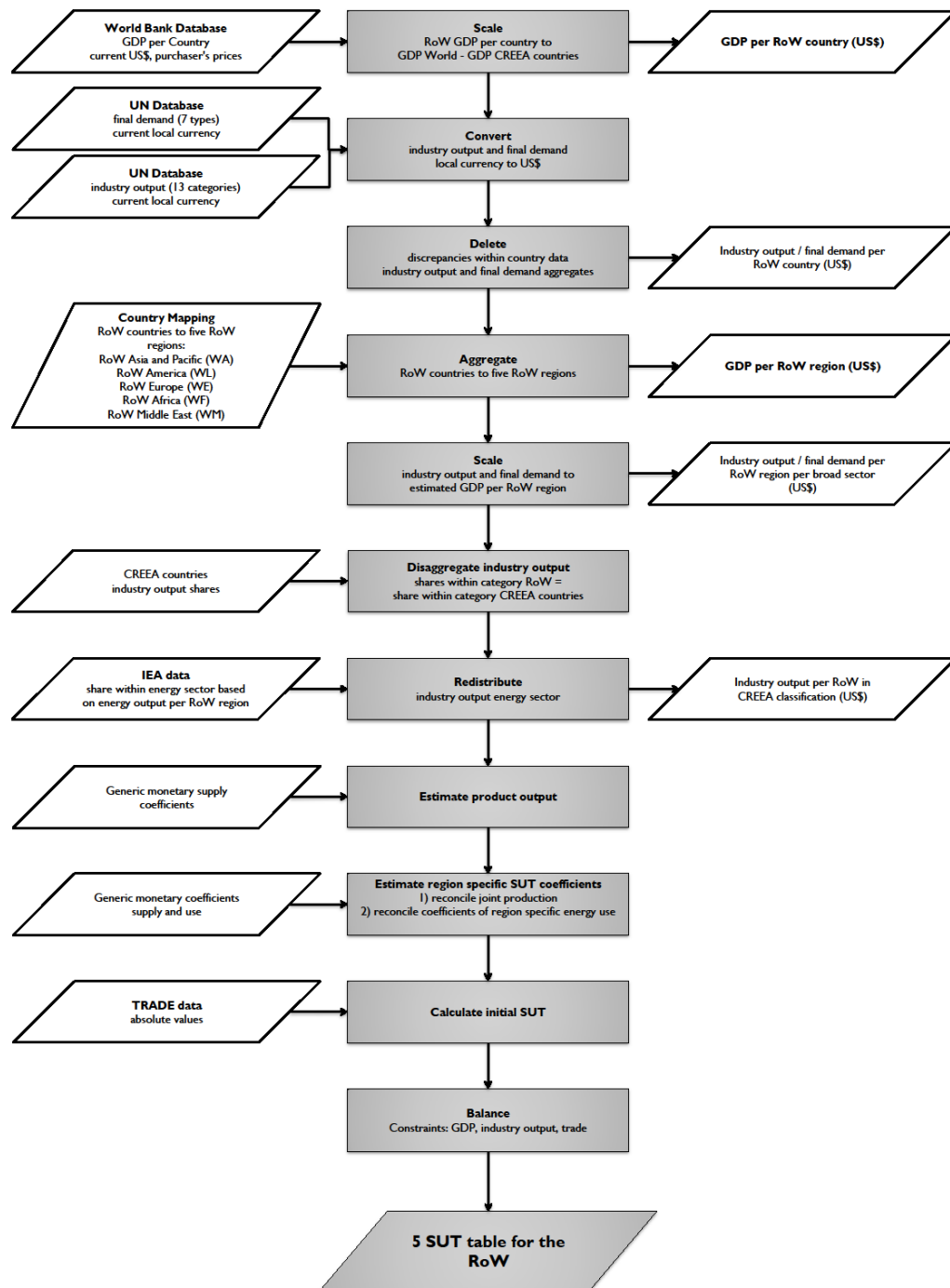


Figure 6.1: Estimation of the RoW

6.2 Results

6.2.1 Macroeconomic data

In 2007, the RoW comprised 11 % of the global GDP (4.48E6 Million Euro out of 4.07E7 Million Euro). Within the RoW the Asian/Pacific and the Middle East regions play the most important part (Table 6.3).

Region	GDP	Industry output
RoW Asia and Pacific	1.25E+06 (28 %)	2.21E+06 (28 %)
RoW America	1.06E+06 (24 %)	1.92E+06 (24 %)
RoW Europe	2.85E+05 (6 %)	6.71E+05 (9 %)
RoW Africa	6.74E+05 (15 %)	1.05E+06 (13 %)
RoW Middle East	1.21E+06 (27 %)	2.00E+06 (25 %)
RoW Sum	4.48E+06 (100 %)	7.86E+06 (100 %)

Table 6.3: Macroeconomic data for the RoW regions, values are given in million Euro.

6.2.2 Differences in technical coefficients

The following two figures highlight the differences in the regions specific SUTs showing the intensity of every product for every industry. Product and industry classification follows the structure given in the Appendix.

Supply Tables

A clear diagonal production structure characterizes the supply tables, followed by the import column vector. Major divergence from the diagonal (steps) occur (1) at the beginning for i10 (Mining of coal and lignite; extraction of peat) which provide different coal products and (2) for i23.2 (Petroleum Refinery) which manufacture different fuel products. (3) A high coproduction is typical for the manufacturing sector which appears as a blue cloud in the middle of the tables. The RoW Middle East shows a distinct coproduction also within the mining sector in the upper left part of the table.

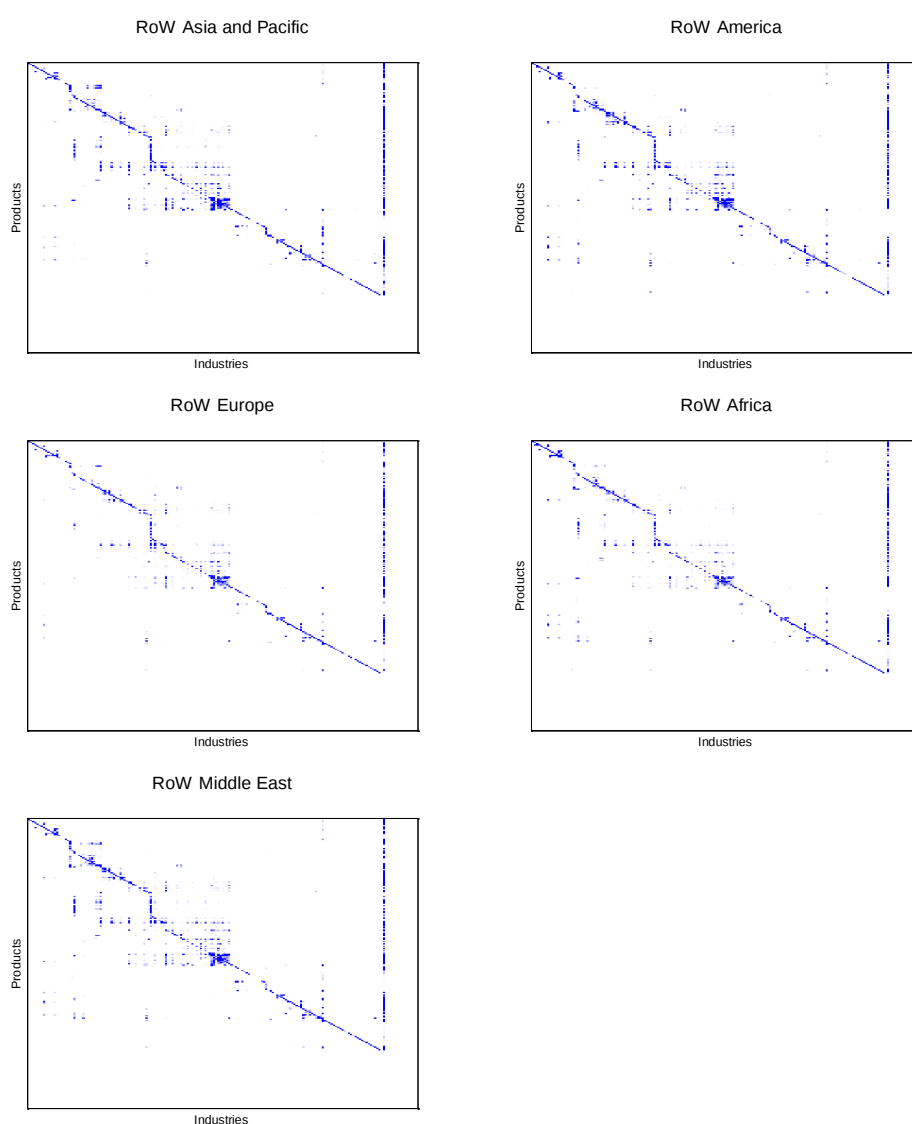


Figure 6.2: Intensity of products/industries for the 5 RoW supply tables

Use Tables

The outstanding difference between the use tables is the almost empty use of products by the mining sector for RoW Europe in the second main column (i10 to i14, cf RoW Europe with RoW Middle East).

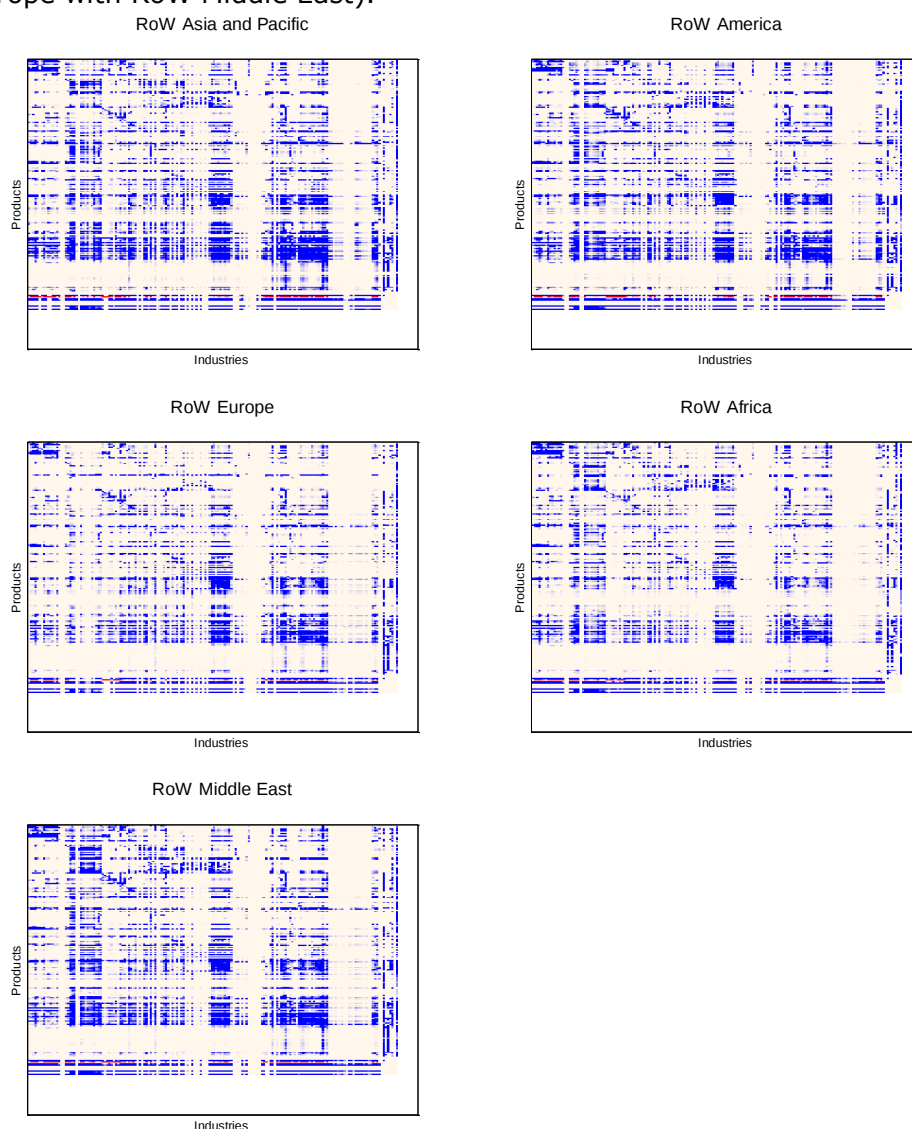


Figure 6.3: Intensity of products/industries for the 5 RoW use tables

7 Labor accounts: methodology

Socio-economic data contains information on employment for 43 countries plus five RoW regions. The indicators available are compensation of employees, total employment and hours worked, separated by gender and skill types, as given in table 7.1.

Values	Description
Compensation of employees	
V_WAGE	<i>Compensation of employees: Total (in millions of national currency)</i>
V_WLSM	Compensation of employees: Low-skilled male workers
V_WLSF	Compensation of employees: Low-skilled female workers
V_WMSM	Compensation of employees: Medium-skilled male workers
V_WMSF	Compensation of employees: Medium-skilled female workers
V_WHSM	Compensation of employees: High-skilled male workers
V_WHSF	Compensation of employees: High-skilled female workers
Employment	
E_NRTO	<i>Number of persons engaged (thousands)</i>
E_NLSM	Number of low-skilled male persons engaged (thousands)
E_NLSF	Number of low-skilled female persons engaged (thousands)
E_NMSM	Number of medium-skilled male persons engaged (thousands)
E_NMSF	Number of medium-skilled female persons engaged (thousands)
E_NHSM	Number of high-skilled male persons engaged (thousands)
E_NHSF	Number of high-skilled female persons engaged (thousands)
Hours worked	
E_HRTO	<i>Total hours worked by persons engaged</i>
E_HLSM	Total hours worked by low-skilled male persons engaged
E_HLSF	Total hours worked by low-skilled female persons engaged
E_HMSM	Total hours worked by medium-skilled male persons engaged
E_HMSF	Total hours worked by medium-skilled female persons engaged
E_HHSM	Total hours worked by high-skilled male persons engaged
E_HHSF	Total hours worked by high-skilled female persons engaged

Table 7.1. Indicators available in CREEA socio-economic database

The database was built in two stages. First, standard measures of labour inputs were collected for each country, used to quantify the dimension of labour impacts of consumption and production in the MRIO model. It consists of total compensation of employees, total employment, total employees and total hours worked by all persons engaged.

However, it is also important to include other measures of labour that will account for the heterogeneity of labour force in each country and industry. Thus, the second stage of data collection corresponded to quality inputs. It consists on information on gender and skill types for each of the first level indicators. It takes into account distinction in hours worked among genders, and wages differences between gender and skill types.

On one hand, in a static MRIO, labour quality data can show the diversity of educational attainment of labour force, women inclusion in the labour market, and payment gap between gender and skill class. On the other hand, when used in a dynamic MRIO, it can show the evolution of labour structure in the countries assessed, and how production and consumption are evolving to exclude or incorporate gaps between gender composition and wages, and thus allowing policy makers and researchers to understand the effects of international trading on socio-economic conditions globally.

In the following sections, we describe the variables used, its characteristics and sources. For detailed country-specific sources, refer to the appendix.

7.1.1 Compensation of Employees, employment and hours worked

Compensation of employees comprises wages, salaries, and employers' social contribution. For each country, this indicator was disaggregated from the National Accounts tables into 163 industries. It was used then to disaggregate employment and hours worked into the MRIO industries, as explained in the following section.

Total employment refers to total persons engaged in each industry in the MRIO. It covers both employees and self-employed persons. Definitions followed are given by the International Labour Organization (ILO). Employees are all persons with formal job attachment, even if in temporarily paid or unpaid leave; and self-employed persons include employers, own-account workers, members of producers' cooperatives, unpaid family workers at work, and persons engaged in the production of economic goods and services for own and household consumption. Number of employees and self-employed are available in the socio-economic database, but not included in the model.

Ypma and Ark (2006) identify three primary sources for labour input. Labour force surveys (LFS) provide reliable information on the composition and characteristics of labour force and account for all employed persons throughout the economy, although it has limited consistency with economic output data. Business surveys, on the other hand, provide detailed employment data often consistent with economic output measures, especially for good producing industries, but information on services sectors, smaller enterprises, and self-employment are usually not collected or underestimated. Micro databases, such as social security statistics, can provide detailed and reliable information on all legal inhabitants, although access can be restricted and very resource-intensive, especially in extensive researches.

For the purpose of this project, primary sources for labour input were national labour force surveys, gathered from the ILO LABORSTA Database⁶, and a combination of labour force and industrial surveys in national accounts, gathered from the STAN Database, published by OECD Stats⁷. While labour data from ILO Database consist of 39 economic sectors, STAN's data cover up to 60 industries, providing better comparability with

⁶ ILO Department of Statistics. International Labour Office Database on Labour Statistics – LABORSTA. Available from: <http://laborsta.ilo.org/>. LABORSTA Database will gradually be replaced with ILOSTAT Database, available from: <http://www.ilo.org/ilostat>.

⁷ OECD Stats. STAN Database for Structural Analysis. Available from: <http://stats.oecd.org/Index.aspx?DataSetCode=STAN08BIS>

economic output in the 163 sectors of the MRIO. However, the latter is only available for OECD countries.

Albeit there is a harmonization in labour force accountings, employment can be given both in persons and in number of jobs. While the first considers that a multiple job holder counts for one, the latter counts several units per individual, and this difference can have significant effects on labour statistics. According to Lequiller (2004), multiple job holders can correspond to more than 5% of employed persons. Only five countries (Austria, Canada, Japan, United Kingdom and United States) count employment as number of jobs rather than number of persons. However, this difference was not addressed, and thus, employment results, in number of persons, can be slightly overestimated for these countries.

Hours worked, on the other hand, can be classified in four different types, which vary according to which hours are accounted for:

- *Hours actually worked* covers all types of workers, and relates to all the time that the persons spent on work activities during the reference period, whether paid or unpaid, but excluding time not worked, such as in annual, parental or sick leaves, public holidays, meal breaks, and commuter travel;
- *Hours paid for* include all hours paid for, whether worked or not. It comprises all paid leaves, and excludes hours not paid for, such as unpaid overtime;
- *Normal hours of work* covers only paid employees, and refers to hours of work established in agreements and labour regulation, and differ from hours paid for by excluding all overtime;
- *Hours usually worked* relates to average hours most commonly worked per week in paid and self-employment during a reference period, including usual paid and unpaid overtime.

The use of each category will depend on the aim of the research. For the purpose of this project, we consider *hours actually worked*, since it reflects the productivity of the industry, and are the usual output of hours worked in labour force surveys. Exceptions are Brazil and Ireland, which relate to *hours usually worked*, and Mexico, which publishes *normal hours of work*.

7.1.1.1 Disaggregation of labour inputs in the MRIO

Labour inputs were then disaggregated from broad economic sectors into industries in the MRIO according to the compensation of employees:

$$NR_i = NR_g (wage_i / wage_g)$$

Where:

NR_i = Number of persons engaged in industry i (in thousands)

NR_g = Number of persons engaged in broad sector g (in thousands)

$wage_i$ = Compensation of employees of industry i (in millions of national currency)

$wage_g$ = Sum of compensation of employees in all industries comprising broad sector g

It was considered that, inside a broad economic sector industry, average wages would be similar, as well as hours worked per person. For example, for the “*pulp, paper and paper products*” broad sector, which comprises the industries “*pulp*”, “*re-processing of*

secondary paper into new pulp" and *"paper"*, total number of persons engaged were divided proportionally between the industries according to their shares in total compensation of employees in the broad sector.

For estimating total hours worked in each industry, it was assumed that hours worked per person was similar among industries in the same broad economic sector. While OECD Stats offer total hours worked for each industry, ILO gives average weekly hours worked by person for each sector. For hours worked in each industry in non-OECD countries, we multiplied average weekly hours by the number of persons employed and by 52 weeks. We also considered same hours worked between employees and self-employed, as well as between skill levels. Difference in hours worked between genders was accounted for when available.

When there was no data for a specific industry, average hours worked in the entire economy was used. This can lead to errors in total hours worked, especially in the agriculture and fishing sectors, and in private households with employed people. Because these sectors usually involve greater share of self-employed workers than employees, frequently have a significant number of persons working for their own subsistence and have different dynamics than other good-producing industries, total hours worked in these sectors can be inaccurately estimated for some countries⁸.

⁸ Countries with no specific information on hours worked in the agricultural sector are Canada and Taiwan. Countries with no specific information on hours worked for private households with employed persons are Bulgaria, Canada, China, Japan, Malta, Romania, Russia, Taiwan, and Turkey.

7.1.2 Labour types

Labour inputs are divided for gender and skill types. We use three skill types (low-, medium-, and high-skilled), based on occupations and educational attainment levels, as related in table 7.2. For occupations, we use the definition from the *International Standard Classification of Occupations* (ILO 2012) and, for educational attainment, the *International Standard Classification of Education* (UNESCO 2012).

Skill type	Occupations ^a	Educational attainment levels ^b
Low-skilled	9 Elementary occupations	0 Less than primary education 1 Primary education 2 Lower secondary education
Medium-skilled	4 Clerical support workers 5 Services and sales workers 6 Skilled agricultural, forestry and fishery workers 7 Craft and related trades workers 8 Plant and machine operators, and assemblers	3 Upper secondary education 4 Post-secondary non-tertiary education
High-skilled	1 Managers 2 Professionals 3 Technicians and associate professionals	5 Short-cycle tertiary education 6 Bachelor's or equivalent level 7 Master's or equivalent level 8 Doctoral or equivalent level

Table 7.2. Correlation between skill types, occupations, and educational attainment levels
a) ISCO - 2008; b) ISCED - 2011

We provide industry-level information on labour types for persons engaged, hours worked, and relative share in compensation of employees, reflecting the heterogeneity of labour force and differences in remuneration by workers of different genders and skill levels.

The main source for gender and skill types information was LFS, gathered from ILO LABORSTA Database or from national statistical offices. Though number of workers by skill type is often available from these surveys, they usually do not account for hours worked or wages. Therefore, we assume no distinction in hours worked per week for different skill types.

To calculate the distribution of compensation of employees, we use relative wages inside a sector. That means that the relative difference between wages for high- and low-skilled workers would be similar inside a broad sector, even if the absolute wages are not similar. Relative wages were calculated from earning and income surveys, collected from national statistics offices, from the EU Structure of Earnings Survey for 2006 (EUROSTAT

2006), and, for countries with restrict access to data, relative wages were calculated from the EU KLEMS (2008) and WIOD Databases (2012).

Due to the high aggregation level for this data, labour types were calculated as shares of total inputs. We assume that the distribution of skilled workers would not differ greatly among sub-industries in an aggregated industry⁹, and therefore, same distribution of gender and skill types can be applied inside a broad economic sector. Table 7.3 presents the aggregate industry sectors for which labour types shares were calculated.

Code	Industry
A & B	Agriculture, forestry, hunting and fishing
C	Mining and quarrying
D	Manufacturing
E	Electricity, gas and water supply
F	Construction
G	Wholesale and retail trade
H	Hotels and restaurants
I	Transport, storage and communication
J	Financial intermediation
K	Real estate, renting and business activities
L	Public administration and defence; compulsory social security
M	Education
N	Health and social work
O	Other community, social and personal services
P	Private households with employed persons

Table 7.3. Aggregated industries in labour types database

⁹ Although there can be large differences among industries in the manufacturing sector, most of available information was highly aggregated for total manufacturing.

7.1.3 Rest of the World regions

Socio-economic data for the RoW region is also divided in five regions: RoW Asia and Pacific, RoW America, RoW Europe, RoW Africa and RoW Middle East. Total employment for each of the RoW regions was estimated by combining data from The World Bank (2011) and from the ILO (2008; 2009). Level of disaggregation for labour was in three major groups: Agriculture, forestry and fishing; Industry; and Services.

Estimates for hours worked, labour types and average differences in wages according to skill levels were estimated using proxies, presented in table 7.4. Countries serving as proxies were chosen according to the following characteristics:

- *Hours worked*: Out of the countries in CREEA, average weekly hours worked per person were considered as the closest to those from countries in the same region, according to data available from ILO LABORSTA;
- *Gender share*: Proxies for estimating the share of women in the economy were chosen according to average share of women in non-agricultural sector. Data for countries in the CREEA region were compared to those from the RoW region available in The World Bank;
- *Skill type*: Average skill types were chosen according to the average share of education attainment (primary, secondary and tertiary education, with data from The World Bank) in the entire economy. Due to the low availability of this information, the closest distribution from the CREEA countries with the available information for the RoW region was chosen;
- *Wages for skill types*: Differences in wages from skill types were considered from those countries in CREEA in the same region and similar Gini index, based on data from The World Bank.

RoW region	Proxies
RoW America	Mexico, Brazil
RoW Africa	South Africa
RoW Europe	Spain, Poland
RoW Asia and Pacific	Japan, Australia
RoW Middle East	Turkey

Table 7.4. Rest of the World regions and proxies used for hours worked and labour types

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9 Appendix

9.1 APPENDIX A - Classifications

9.1.1 EXIOBASE 2.0 Product Classification

No	Name	Code1	Code2
1	Paddy rice	p01.a	C_PARI
2	Wheat	p01.b	C_WHEA
3	Cereal grains nec	p01.c	C_OCER
4	Vegetables, fruit, nuts	p01.d	C_FVEG
5	Oil seeds	p01.e	C_OILS
6	Sugar cane, sugar beet	p01.f	C_SUGB
7	Plant-based fibers	p01.g	C_FIBR
8	Crops nec	p01.h	C_OTCR
9	Cattle	p01.i	C_CATL
10	Pigs	p01.j	C_PIGS
11	Poultry	p01.k	C_PLTR
12	Meat animals nec	p01.l	C_OMEA
13	Animal products nec	p01.m	C_OANP
14	Raw milk	p01.n	C_MILK
15	Wool, silk-worm cocoons	p01.o	C_WOOL
16	Manure (conventional treatment)	p01.w.1	C_MANC
17	Manure (biogas treatment)	p01.w.2	C_MANB
18	Products of forestry, logging and related services (02)	p02	C_FORE
19	Fish and other fishing products; services incidental of fishing (05)	p05	C_FISH
20	Anthracite	p10.a	C_ANTH
21	Coking Coal	p10.b	C_COKC
22	Other Bituminous Coal	p10.c	C_OTBC
23	Sub-Bituminous Coal	p10.d	C_SUBC
24	Patent Fuel	p10.e	C_PATF
25	Lignite/Brown Coal	p10.f	C_LIBC
26	BKB/Peat Briquettes	p10.g	C_BKBP
27	Peat	p10.h	C_PEAT
28	Crude petroleum and services related to crude oil extraction, excluding surveying	p11.a	C_COIL
29	Natural gas and services related to natural gas extraction, excluding surveying	p11.b	C_GASE
30	Natural Gas Liquids	p11.b.1	C_GASL
31	Other Hydrocarbons	p11.c	C_OGPL
32	Uranium and thorium ores (12)	p12	C_ORAN
33	Iron ores	p13.1	C_IRON
34	Copper ores and concentrates	p13.20.11	C_COPO
35	Nickel ores and concentrates	p13.20.12	C_NIKO
36	Aluminium ores and concentrates	p13.20.13	C_ALUO
37	Precious metal ores and concentrates	p13.20.14	C_PREO
38	Lead, zinc and tin ores and concentrates	p13.20.15	C_LZTO
39	Other non-ferrous metal ores and concentrates	p13.20.16	C_ONFO
40	Stone	p14.1	C_STON

No	Name	Code1	Code2
41	Sand and clay	p14.2	C_SDCL
42	Chemical and fertilizer minerals, salt and other mining and quarrying products n.e.c.	p14.3	C_CHMF
43	Products of meat cattle	p15.a	C_PCAT
44	Products of meat pigs	p15.b	C_PPIG
45	Products of meat poultry	p15.c	C_PPLT
46	Meat products nec	p15.d	C_POME
47	products of Vegetable oils and fats	p15.e	C_VOIL
48	Dairy products	p15.f	C_DAIR
49	Processed rice	p15.g	C_RICE
50	Sugar	p15.h	C_SUGR
51	Food products nec	p15.i	C_OFOD
52	Beverages	p15.j	C_BEVR
53	Fish products	p15.k	C_FSHP
54	Tobacco products (16)	p16	C_TOBC
55	Textiles (17)	p17	C_TEXT
56	Wearing apparel; furs (18)	p18	C_GARM
57	Leather and leather products (19)	p19	C_LETH
58	Wood and products of wood and cork (except furniture); articles of straw and plaiting materials (20)	p20	C_WOOD
59	Wood material for treatment, Re-processing of secondary wood material into new wood material	p20.w	C_WOOW
60	Pulp	p21.1	C_PULP
61	Secondary paper for treatment, Re-processing of secondary paper into new pulp	p21.w.1	C_PAPR
62	Paper and paper products	p21.2	C_PAPE
63	Printed matter and recorded media (22)	p22	C_MDIA
64	Coke Oven Coke	p23.1.a	C_COKE
65	Gas Coke	p23.1.b	C_GCOK
66	Coal Tar	p23.1.c	C_COTA
67	Motor Gasoline	p23.20.a	C_MGSL
68	Aviation Gasoline	p23.20.b	C_AGSL
69	Gasoline Type Jet Fuel	p23.20.c	C_GJET
70	Kerosene Type Jet Fuel	p23.20.d	C_KJET
71	Kerosene	p23.20.e	C_KERO
72	Gas/Diesel Oil	p23.20.f	C_DOIL
73	Heavy Fuel Oil	p23.20.g	C_FOIL
74	Refinery Gas	p23.20.h	C_RGAS
75	Liquefied Petroleum Gases (LPG)	p23.20.i	C_LPGA
76	Refinery Feedstocks	p23.20.j	C_REFF
77	Ethane	p23.20.k	C_ETHA
78	Naphtha	p23.20.l	C_NAPT
79	White Spirit & SBP	p23.20.m	C_WHSP
80	Lubricants	p23.20.n	C_LUBR
81	Bitumen	p23.20.o	C_BITU
82	Paraffin Waxes	p23.20.p	C_PARW
83	Petroleum Coke	p23.20.q	C_PETC
84	Non-specified Petroleum Products	p23.20.r	C_NSPP

No	Name	Code1	Code2
85	Nuclear fuel	p23.3	C_NUCF
86	Plastics, basic	p24.a	C_PLAS
87	Secondary plastic for treatment, Re-processing of secondary plastic into new plastic	p24.a.w	C_PLAW
88	N-fertiliser	p24.b	C_NFER
89	P- and other fertiliser	p24.c	C_PFER
90	Chemicals nec	p24.d	C_CHEM
91	Charcoal	p24.e	C_CHAR
92	Additives/Blending Components	p24.f	C_ADDC
93	Biogasoline	p24.g	C_BIOG
94	Biodiesels	p24.h	C_BIOD
95	Other Liquid Biofuels	p24.i	C_OBIO
96	Rubber and plastic products (25)	p25	C_RUBP
97	Glass and glass products	p26.a	C_GLAS
98	Secondary glass for treatment, Re-processing of secondary glass into new glass	p26.w.1	C_GLAW
99	Ceramic goods	p26.b	C_CRMC
100	Bricks, tiles and construction products, in baked clay	p26.c	C_BRIK
101	Cement, lime and plaster	p26.d	C_CMNT
102	Ash for treatment, Re-processing of ash into clinker	p26.d.w	C_ASHW
103	Other non-metallic mineral products	p26.e	C_ONMM
104	Basic iron and steel and of ferro-alloys and first products thereof	p27.a	C_STEL
105	Secondary steel for treatment, Re-processing of secondary steel into new steel	p27.a.w	C_STEW
106	Precious metals	p27.41	C_PREM
107	Secondary precious metals for treatment, Re-processing of secondary precious metals into new precious metals	p27.41.w	C_PREW
108	Aluminium and aluminium products	p27.42	C_ALUM
109	Secondary aluminium for treatment, Re-processing of secondary aluminium into new aluminium	p27.42.w	C_ALUW
110	Lead, zinc and tin and products thereof	p27.43	C_LZTP
111	Secondary lead for treatment, Re-processing of secondary lead into new lead	p27.43.w	C_LZTW
112	Copper products	p27.44	C_COPP
113	Secondary copper for treatment, Re-processing of secondary copper into new copper	p27.44.w	C_COPW
114	Other non-ferrous metal products	p27.45	C_ONFM
115	Secondary other non-ferrous metals for treatment, Re-processing of secondary other non-ferrous metals into new other non-ferrous metals	p27.45.w	C_ONFW
116	Foundry work services	p27.5	C_METC
117	Fabricated metal products, except machinery and equipment (28)	p28	C_FABM
118	Machinery and equipment n.e.c. (29)	p29	C_MACH
119	Office machinery and computers (30)	p30	C_OFMA
120	Electrical machinery and apparatus n.e.c. (31)	p31	C_ELMA
121	Radio, television and communication equipment and apparatus (32)	p32	C_RATV
122	Medical, precision and optical instruments, watches and clocks (33)	p33	C_MEIN
123	Motor vehicles, trailers and semi-trailers (34)	p34	C_MOTO
124	Other transport equipment (35)	p35	C_OTRE

No	Name	Code1	Code2
125	Furniture; other manufactured goods n.e.c. (36)	p36	C_FURN
126	<i>Secondary raw materials</i>	<i>p37</i>	<i>C_RYMS</i>
127	<i>Bottles for treatment, Recycling of bottles by direct reuse</i>	<i>p37.w.1</i>	<i>C_BOTW</i>
128	Electricity by coal	p40.11.a	C_POWC
129	Electricity by gas	p40.11.b	C_POWG
130	Electricity by nuclear	p40.11.c	C_POWN
131	Electricity by hydro	p40.11.d	C_POWH
132	Electricity by wind	p40.11.e	C_POWW
133	Electricity by petroleum and other oil derivatives	p40.11.f	C_POWP
134	Electricity by biomass and waste	p40.11.g	C_POWB
135	Electricity by solar photovoltaic	p40.11.h	C_POWS
136	Electricity by solar thermal	p40.11.i	C_POWE
137	Electricity by tide, wave, ocean	p40.11.j	C_POWO
138	Electricity by Geothermal	p40.11.k	C_POWM
139	Electricity nec	p40.11.l	C_POWZ
140	Transmission services of electricity	p40.12	C_POWT
141	Distribution and trade services of electricity	p40.13	C_POWD
142	Coke oven gas	p40.2.a	C_COOG
143	Blast Furnace Gas	p40.2.b	C_MBFG
144	Oxygen Steel Furnace Gas	p40.2.c	C_MOSG
145	Gas Works Gas	p40.2.d	C_MGWG
146	Biogas	p40.2.e	C_MBIO
147	Distribution services of gaseous fuels through mains	p40.2.1	C_GASD
148	Steam and hot water supply services	p40.3	C_HWAT
149	Collected and purified water, distribution services of water (41)	p41	C_WATR
150	Construction work (45)	p45	C_CONS
151	<i>Secondary construction material for treatment, Re-processing of secondary construction material into aggregates</i>	<i>p45.w</i>	<i>C_CONW</i>
152	Sale, maintenance, repair of motor vehicles, motor vehicles parts, motorcycles, motor cycles parts and accessoires	p50.a	C_TDMO
153	Retail trade services of motor fuel	p50.b	C_TDFU
154	Wholesale trade and commission trade services, except of motor vehicles and motorcycles (51)	p51	C_TDWH
155	Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods (52)	p52	C_TDRT
156	Hotel and restaurant services (55)	p55	C_HORE
157	Railway transportation services	p60.1	C_TRAI
158	Other land transportation services	p60.2	C_TLND
159	Transportation services via pipelines	p60.3	C_TPIP
160	Sea and coastal water transportation services	p61.1	C_TWAS
161	Inland water transportation services	p61.2	C_TWAI
162	Air transport services (62)	p62	C_TAIR
163	Supporting and auxiliary transport services; travel agency services (63)	p63	C_TAUX
164	Post and telecommunication services (64)	p64	C_PTEL
165	Financial intermediation services, except insurance and pension funding services (65)	p65	C_FINT
166	Insurance and pension funding services, except compulsory	p66	C_FINS

No	Name	Code1	Code2
	social security services (66)		
167	Services auxiliary to financial intermediation (67)	p67	C_FAUX
168	Real estate services (70)	p70	C_REAL
169	Renting services of machinery and equipment without operator and of personal and household goods (71)	p71	C_MARE
170	Computer and related services (72)	p72	C_COMP
171	Research and development services (73)	p73	C_RESD
172	Other business services (74)	p74	C_OBUS
173	Public administration and defence services; compulsory social security services (75)	p75	C_PADF
174	Education services (80)	p80	C_EDUC
175	Health and social work services (85)	p85	C_HEAL
176	Food waste for treatment: incineration	p90.1.a	C_INCF
177	Paper waste for treatment: incineration	p90.1.b	C_INCP
178	Plastic waste for treatment: incineration	p90.1.c	C_INCL
179	Inert/metal waste for treatment: incineration	p90.1.d	C_INCM
180	Textiles waste for treatment: incineration	p90.1.e	C_INCT
181	Wood waste for treatment: incineration	p90.1.f	C_INCW
182	Oil/hazardous waste for treatment: incineration	p90.1.g	C_INCO
183	Food waste for treatment: biogasification and land application	p90.2.a	C_BIOF
184	Paper waste for treatment: biogasification and land application	p90.2.b	C_BIOP
185	Sewage sludge for treatment: biogasification and land application	p90.2.c	C_BIOS
186	Food waste for treatment: composting and land application	p90.3.a	C_COMF
187	Paper and wood waste for treatment: composting and land application	p90.3.b	C_COMW
188	Food waste for treatment: waste water treatment	p90.4.a	C_WASF
189	Other waste for treatment: waste water treatment	p90.4.b	C_WASO
190	Food waste for treatment: landfill	p90.5.a	C_LANF
191	Paper for treatment: landfill	p90.5.b	C_LANP
192	Plastic waste for treatment: landfill	p90.5.c	C_LANL
193	Inert/metal/hazardous waste for treatment: landfill	p90.5.d	C_LANI
194	Textiles waste for treatment: landfill	p90.5.e	C_LANT
195	Wood waste for treatment: landfill	p90.5.f	C_LANW
196	Membership organisation services n.e.c. (91)	p91	C_ORGA
197	Recreational, cultural and sporting services (92)	p92	C_RECR
198	Other services (93)	p93	C_OSER
199	Private households with employed persons (95)	p95	C_PRHH
200	Extra-territorial organizations and bodies	p99	C_EXTO

9.1.2 EXIOBASE 2.0 Industry Classification

No	EXIOBASE 2.0 Industry sectors	Code1	Code2
1	Cultivation of paddy rice	i01.a	A_PARI
2	Cultivation of wheat	i01.b	A_WHEA
3	Cultivation of cereal grains nec	i01.c	A_OCER
4	Cultivation of vegetables, fruit, nuts	i01.d	A_FVEG
5	Cultivation of oil seeds	i01.e	A_OILS
6	Cultivation of sugar cane, sugar beet	i01.f	A_SUGB
7	Cultivation of plant-based fibers	i01.g	A_FIBR
8	Cultivation of crops nec	i01.h	A_OTCR
9	Cattle farming	i01.i	A_CATL
10	Pigs farming	i01.j	A_PIGS
11	Poultry farming	i01.k	A_PLTR
12	Meat animals nec	i01.l	A_OMEA
13	Animal products nec	i01.m	A_OANP
14	Raw milk	i01.n	A_MILK
15	Wool, silk-worm cocoons	i01.o	A_WOOL
16	Manure treatment (conventional), storage and land application	i01.w.1	A_MANC
17	Manure treatment (biogas), storage and land application	i01.w.2	A_MANB
18	Forestry, logging and related service activities (02)	i02	A_FORE
19	Fishing, operating of fish hatcheries and fish farms; service activities incidental to fishing (05)	i05	A_FISH
20	Mining of coal and lignite; extraction of peat (10)	i10	A_COAL
21	Extraction of crude petroleum and services related to crude oil extraction, excluding surveying	i11.a	A_COIL
22	Extraction of natural gas and services related to natural gas extraction, excluding surveying	i11.b	A_GASE
23	Extraction, liquefaction, and regasification of other petroleum and gaseous materials	i11.c	A_OGPL
24	Mining of uranium and thorium ores (12)	i12	A_ORAN
25	Mining of iron ores	i13.1	A_IRON
26	Mining of copper ores and concentrates	i13.20.11	A_COPO
27	Mining of nickel ores and concentrates	i13.20.12	A_NIKO
28	Mining of aluminium ores and concentrates	i13.20.13	A_ALUO
29	Mining of precious metal ores and concentrates	i13.20.14	A_PREO
30	Mining of lead, zinc and tin ores and concentrates	i13.20.15	A_LZTO
31	Mining of other non-ferrous metal ores and concentrates	i13.20.16	A_ONFO
32	Quarrying of stone	i14.1	A_STON
33	Quarrying of sand and clay	i14.2	A_SDCL
34	Mining of chemical and fertilizer minerals, production of salt, other mining and quarrying n.e.c.	i14.3	A_CHMF
35	Processing of meat cattle	i15.a	A_PCAT
36	Processing of meat pigs	i15.b	A_PPIG
37	Processing of meat poultry	i15.c	A_PPLT
38	Production of meat products nec	i15.d	A_POME
39	Processing vegetable oils and fats	i15.e	A_VOIL

No	EXIOBASE 2.0 Industry sectors	Code1	Code2
40	Processing of dairy products	i15.f	A_DAIR
41	Processed rice	i15.g	A_RICE
42	Sugar refining	i15.h	A_SUGR
43	Processing of Food products nec	i15.i	A_OFOD
44	Manufacture of beverages	i15.j	A_BEVR
45	Manufacture of fish products	i15.k	A_FSHP
46	Manufacture of tobacco products (16)	i16	A_TOBC
47	Manufacture of textiles (17)	i17	A_TEXT
48	Manufacture of wearing apparel; dressing and dyeing of fur (18)	i18	A_GARM
49	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear (19)	i19	A_LETH
50	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials (20)	i20	A_WOOD
51	Re-processing of secondary wood material into new wood material	i20.w	A_WOOW
52	Pulp	i21.1	A_PULP
53	Re-processing of secondary paper into new pulp	i21.w.1	A_PAPR
54	Paper	i21.2	A_PAPE
55	Publishing, printing and reproduction of recorded media (22)	i22	A_MDIA
56	Manufacture of coke oven products	i23.1	A_COKE
57	Petroleum Refinery	i23.2	A_REFN
58	Processing of nuclear fuel	i23.3	A_NUCF
59	Plastics, basic	i24.1	A_PLAS
60	Re-processing of secondary plastic into new plastic	i24.1.w	A_PLAW
61	N-fertiliser	i24.2	A_NFER
62	P- and other fertiliser	i24.3	A_PFER
63	Chemicals nec	i24.4	A_CHEM
64	Manufacture of rubber and plastic products (25)	i25	A_RUBP
65	Manufacture of glass and glass products	i26.a	A_GLAS
66	Re-processing of secondary glass into new glass	i26.w.1	A_GLAW
67	Manufacture of ceramic goods	i26.b	A_CRMC
68	Manufacture of bricks, tiles and construction products, in baked clay	i26.c	A_BRIK
69	Manufacture of cement, lime and plaster	i26.d	A_CMNT
70	Re-processing of ash into clinker	i26.d.w	A_ASHW
71	Manufacture of other non-metallic mineral products n.e.c.	i26.e	A_ONMM
72	Manufacture of basic iron and steel and of ferro-alloys and first products thereof	i27.a	A_STEL
73	Re-processing of secondary steel into new steel	i27.a.w	A_STEW
74	Precious metals production	i27.41	A_PREM
75	Re-processing of secondary precious metals into new precious metals	i27.41.w	A_PREW
76	Aluminium production	i27.42	A_ALUM
77	Re-processing of secondary aluminium into new aluminium	i27.42.w	A_ALUW
78	Lead, zinc and tin production	i27.43	A_LZTP
79	Re-processing of secondary lead into new lead	i27.43.w	A_LZTW
80	Copper production	i27.44	A_COPP

No	EXIOBASE 2.0 Industry sectors	Code1	Code2
81	Re-processing of secondary copper into new copper	i27.44.w	A_COPW
82	Other non-ferrous metal production	i27.45	A_ONFM
83	Re-processing of secondary other non-ferrous metals into new other non-ferrous metals	i27.45.w	A_ONFW
84	Casting of metals	i27.5	A_METC
85	Manufacture of fabricated metal products, except machinery and equipment (28)	i28	A_FABM
86	Manufacture of machinery and equipment n.e.c. (29)	i29	A_MACH
87	Manufacture of office machinery and computers (30)	i30	A_OFMA
88	Manufacture of electrical machinery and apparatus n.e.c. (31)	i31	A_ELMA
89	Manufacture of radio, television and communication equipment and apparatus (32)	i32	A_RATV
90	Manufacture of medical, precision and optical instruments, watches and clocks (33)	i33	A_MEIN
91	Manufacture of motor vehicles, trailers and semi-trailers (34)	i34	A_MOTO
92	Manufacture of other transport equipment (35)	i35	A_OTRE
93	Manufacture of furniture; manufacturing n.e.c. (36)	i36	A_FURN
94	Recycling of waste and scrap	i37	A_RYMS
95	Recycling of bottles by direct reuse	i37.w.1	A_BOTW
96	Production of electricity by coal	i40.11.a	A_POWC
97	Production of electricity by gas	i40.11.b	A_POWG
98	Production of electricity by nuclear	i40.11.c	A_POWN
99	Production of electricity by hydro	i40.11.d	A_POWH
100	Production of electricity by wind	i40.11.e	A_POWW
101	Production of electricity by petroleum and other oil derivatives	i40.11.f	A_POWP
102	Production of electricity by biomass and waste	i40.11.g	A_POWB
103	Production of electricity by solar photovoltaic	i40.11.h	A_POWS
104	Production of electricity by solar thermal	i40.11.i	A_POWE
105	Production of electricity by tide, wave, ocean	i40.11.j	A_POWO
106	Production of electricity by Geothermal	i40.11.k	A_POWM
107	Production of electricity nec	i40.11.l	A_POWZ
108	Transmission of electricity	i40.12	A_POWT
109	Distribution and trade of electricity	i40.13	A_POWD
110	Manufacture of gas; distribution of gaseous fuels through mains	i40.2	A_GASD
111	Steam and hot water supply	i40.3	A_HWAT
112	Collection, purification and distribution of water (41)	i41	A_WATR
113	Construction (45)	i45	A_CONS
114	Re-processing of secondary construction material into aggregates	i45.w	A_CONW
115	Sale, maintenance, repair of motor vehicles, motor vehicles parts, motorcycles, motor cycles parts and accessoires	i50.a	A_TDMO
116	Retail sale of automotive fuel	i50.b	A_TDFU
117	Wholesale trade and commission trade, except of motor vehicles and motorcycles (51)	i51	A_TDWH
118	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods (52)	i52	A_TDRT
119	Hotels and restaurants (55)	i55	A_HORE
120	Transport via railways	i60.1	A_TRAI

No	EXIOBASE 2.0 Industry sectors	Code1	Code2
121	Other land transport	i60.2	A_TLND
122	Transport via pipelines	i60.3	A_TPIP
123	Sea and coastal water transport	i61.1	A_TWAS
124	Inland water transport	i61.2	A_TWAI
124	Air transport (62)	i62	A_TAIR
126	Supporting and auxiliary transport activities; activities of travel agencies (63)	i63	A_TAUX
127	Post and telecommunications (64)	i64	A_PTEL
128	Financial intermediation, except insurance and pension funding (65)	i65	A_FINT
129	Insurance and pension funding, except compulsory social security (66)	i66	A_FINS
130	Activities auxiliary to financial intermediation (67)	i67	A_FAUX
131	Real estate activities (70)	i70	A_REAL
132	Renting of machinery and equipment without operator and of personal and household goods (71)	i71	A_MARE
133	Computer and related activities (72)	i72	A_COMP
134	Research and development (73)	i73	A_RESD
135	Other business activities (74)	i74	A_OBUS
136	Public administration and defence; compulsory social security (75)	i75	A_PADF
137	Education (80)	i80	A_EDUC
138	Health and social work (85)	i85	A_HEAL
139	Incineration of waste: Food	i90.1.a	A_INCF
140	Incineration of waste: Paper	i90.1.b	A_INCP
141	Incineration of waste: Plastic	i90.1.c	A_INCL
142	Incineration of waste: Metals and Inert materials	i90.1.d	A_INCM
143	Incineration of waste: Textiles	i90.1.e	A_INCT
144	Incineration of waste: Wood	i90.1.f	A_INCW
145	Incineration of waste: Oil/Hazardous waste	i90.1.g	A_INCO
146	Biogasification of food waste, incl. land application	i90.3.a	A_BIOF
147	Biogasification of paper, incl. land application	i90.3.b	A_BIOP
148	Biogasification of sewage sludge, incl. land application	i90.3.c	A_BIOS
149	Composting of food waste, incl. land application	i90.4.a	A_COMF
150	Composting of paper and wood, incl. land application	i90.4.b	A_COMW
151	Waste water treatment, food	i90.5.a	A_WASF
152	Waste water treatment, other	i90.5.b	A_WASO
153	Landfill of waste: Food	i90.6.a	A_LANF
154	Landfill of waste: Paper	i90.6.b	A_LANP
155	Landfill of waste: Plastic	i90.6.c	A_LANL
156	Landfill of waste: Inert/metal/hazardous	i90.6.d	A_LANI
157	Landfill of waste: Textiles	i90.6.e	A_LANT
158	Landfill of waste: Wood	i90.6.f	A_LANW
159	Activities of membership organisation n.e.c. (91)	i91	A_ORGA
160	Recreational, cultural and sporting activities (92)	i92	A_RECR
161	Other service activities (93)	i93	A_OSER
162	Private households with employed persons (95)	i95	A_PRHH
163	Extra-territorial organizations and bodies	i99	A_EXTO

9.1.3 CREEA country classification

Number	Country/Region	Code	EU member
1	Austria	AT	EU
2	Belgium	BE	EU
3	Bulgaria	BG	EU
4	Cyprus	CY	EU
5	Czech Republic	CZ	EU
6	Germany	DE	EU
7	Denmark	DK	EU
8	Estonia	EE	EU
9	Spain	ES	EU
10	Finland	FI	EU
11	France	FR	EU
12	Greece	GR	EU
13	Hungary	HU	EU
14	Ireland	IE	EU
15	Italy	IT	EU
16	Lithuania	LT	EU
17	Luxembourg	LU	EU
18	Latvia	LV	EU
19	Malta	MT	EU
20	Netherlands	NL	EU
21	Poland	PL	EU
22	Portugal	PT	EU
23	Romania	RO	EU
24	Sweden	SE	EU
25	Slovenia	SI	EU
26	Slovakia	SK	EU
27	United Kingdom	GB	EU
28	United States	US	nonEU
29	Japan	JP	nonEU
30	China	CN	nonEU
31	Canada	CA	nonEU
32	South Korea	KR	nonEU
33	Brazil	BR	nonEU
34	India	IN	nonEU
35	Mexico	MX	nonEU
36	Russia	RU	nonEU
37	Australia	AU	nonEU
38	Switzerland	CH	nonEU
39	Turkey	TR	nonEU
40	Taiwan	TW	nonEU
41	Norway	NO	nonEU
42	Indonesia	ID	nonEU
43	South Africa	ZA	nonEU
44	RoW Asia and Pacific	WA	nonEU
45	RoW America	WL	nonEU
46	RoW Europe	WE	nonEU
47	RoW Africa	WF	nonEU
48	RoW Middle East	WM	nonEU

9.2 APPENDIX B - Labour accounts : Country-specific sources

Code	Country	Employment	Hours of work	Labour types	Wages
AT	Austria	NA	NA	LFS	ES
AU	Australia	LFS	LFS	LFS	EU KLEMS
BE	Belgium	NA	NA	LFS	ES
BG	Bulgaria	LFS	LFS	LFS	ES
BR	Brazil	LFS	LFS	LFS	WIOD
CA	Canada	NA	NA	LFS	EU KLEMS
CH	Switzerland	NA	NA	LFS	ES
CN	China	LFS	LFS	LFS, WIOD	WIOD
CY	Cyprus	LFS	LFS	LFS	ES
CZ	Czech Republic	NA	NA	LFS	ES
DE	Germany	NA	NA	LFS	ES
DK	Denmark	NA	NA	LFS	ES
EE	Estonia	NA	NA	LFS	ES
ES	Spain	NA	NA	LFS	ES
FI	Finland	NA	NA	LFS	ES
FR	France	NA	LFS	LFS	ES
GB	United Kingdom	NA	LFS	LFS	ES
GR	Greece	NA	NA	LFS	ES
HU	Hungary	NA	NA	LFS	ES
ID	Indonesia	LFS	LFS	LFS	WIOD
IE	Ireland	NA	LFS	LFS	ES
IN	India	LFS	LFS	LFS	ES
IT	Italy	NA	NA	LFS	ES
JP	Japan	NA	LFS	LFS	EU KLEMS
KR	South Korea	NA	NA	LFS	WIOD
LT	Lithuania	LFS	LFS	LFS	ES
LU	Luxembourg	NA	LFS	..., WIOD	WIOD
LV	Latvia	LFS	LFS	LFS	ES
MT	Malta	LFS	LFS	LFS	ES
MX	Mexico	LFS	LFS	LFS	WIOD
NL	Netherlands	NA	NA	LFS	ES
NO	Norway	NA	NA	LFS	ES
PL	Poland	NA	LFS	LFS	ES
PT	Portugal	LFS	LFS	LFS	ES
RO	Romania	LFS	LFS	LFS	ES
RU	Russia	LFS	LFS	LFS	WIOD
SE	Sweden	NA	NA	LFS	ES
SI	Slovenia	NA	LFS	LFS	ES
SK	Slovakia	NA	NA	LFS	ES
TR	Turkey	LFS	LFS	LFS	ES
TW	Taiwan	LFS	LFS	..., WIOD	WIOD
US	United States	NA	NA	LFS	EU KLEMS
ZA	South Africa	LFS	LFS	LFS	ES

NA = National Accounts; LFS = Labour Force Surveys; ES = Earnings/Income Surveys; WIOD = WIOD Database; EU KLEMS = EU KLEMS Database; ... = No data available, use of a proxy country for gender shares