Slicing up Global Value Chains

Marcel Timmer [a,*]
Abdul Azeez Erumban[a]
Bart Los[a]
Robert Stehrer[b]
Gaaitzen de Vries[a]

Version June 24, 2011

Paper prepared for NBER's Summer Institute NBER/CRIW Workshop, 19 July, 2011

NB The results in this paper are preliminary and should not be quoted

Affiliations

[a] Groningen Growth and Development Centre, Faculty of Economics and Business, University of Groningen

[b] The Vienna Institute for International Economic Studies (WIIW)

*** Corresponding Author**

Marcel P. Timmer
Groningen Growth and Development Centre
Faculty of Economics and Business
University of Groningen, The Netherlands
m.p.timmer@rug.nl

Abstract

In this paper we provide a new decomposition method for global value chains. Based on an analysis of vertically integrated industries, we trace the flow of final expenditures to factor income around the world. Using a new world input-output database, we find that in 38 out of the 40 countries the degree of vertical integration has increased between 1995 and 2006. We also find strong trends in regional value added shares in worldwide manufacturing expenditure. China was capturing about 11% in 2006, up from 5% in 1995, mainly at the expense of Japan, while the shares of the EU and NAFTA declined only marginally. In China and other developing regions low-skilled workers increased their shares, but not so much as medium-skilled workers and capital. Compensation shares for high-skilled workers have gone up around the world, in particular in the EU and NAFTA.

Acknowledgements:
This paper is part of the World Input-Output Database (WIOD) project funded by the European Commission, Research Directorate General as part of the 7th Framework Programme, Theme 8: Socio-Economic Sciences and Humanities, grant Agreement no: 225 281. More information on the WIOD-project can be found at www.wiod.org.

1. Introduction

The global economy is rapidly integrating through spectacular increases in international trade in goods and services. This is accompanied by a fragmentation of production processes as activities once done in the home economy are increasingly offshored. Fostered by rapidly falling communication, coordination and transport costs, the various stages of production need not be performed near to each other. This has pervasive consequences for the relationships between global patterns of consumption and production, and the distribution of factor incomes around the world (Baldwin 2006; Grossman and Rossi-Hansberg 2008). One of the main concerns of the global fragmentation process is the uneven effects on remuneration of various groups of labourers and capital owners, both within and across countries. Surprisingly, there is no extensive empirical documentation of these links. This paper aims to fill that gap.

Various recent case studies on electronics have shown how global integration has led to what Krugman (1995) called "slicing up the value chain".[1] For example, Dedrick et al. (2010) show that for various iPods and laptops that are manufactured in China, less than 3 per cent of the export value is actually captured by the Chinese activities. The major part of the value is captured by firms in the US, Japan, Korea and Taiwan through delivery of sophisticated intermediate inputs. Similarly, Ali-Yrkkö, Rouvinen, Seppälä and Ylä-Anttila (2011) show that the NOKIA N95 phone, made in China and sold in the US, generates income around the world: 51% in the EU, 28% in the US and only 16% in Asia. These studies suggest that low-skilled activities such as assembling have moved offshore, but developed countries still capture most of the value added generated globally.

Beyond these case-studies and anecdotes, there is little evidence on the wider relevance of these developments due to a lack of data. In this paper we introduce a new industry-level metric that allows us to analyse the value that is added in various stages of regionally dispersed production processes. It is based on a new database that combines national input-output tables, bilateral international trade statistics and data on production factor requirements. A crucial characteristic of this metric is the explicit recognition of national and international trade in intermediates. It is the first attempt to quantify and track the slicing of global value chains into income for labour and capital in various regions in the world. Our global value chain (GVC) analysis will indicate possible trends in where profits are reaped and to whom wages are paid. Our aim is to establish a series of stylised facts that can serve as a starting point for deeper analysis of the causes of these global shifts.

[1] Earlier studies focused mainly on value chains in agriculture, see e.g.Kaplinsky (2000).

Our approach is closely related to the work on measures of vertical specialisation. The seminal work of Hummels et al. (2001) has spurned various attempts to measure the factor content of trade flows such as Reimer (2006), Johnson (2008) and Trefler and Zhu (2010). Other authors aim to measure the factor content of trade for specific countries such as Feenstra and Hong (2010) for China.[2] We follow this literature by acknowledging the important role of international trade in intermediate products. But rather than focussing on the factor content of trade flows, we analyse the link between consumption and factor incomes. In addition, detailed data on production factors allows us to analyse trends in income of labour and capital inputs, and not only overall value added. Our GVC metrics also provide additional quantitative evidence for the trends in global production networks that have been analysed in more qualitative terms by for example Kaplinsky (2000), Gereffi (1999) and Sturgeon, van Biesebroeck and Gereffi (2008). These studies focus on the development of global production networks in particular industries such as textiles and automobiles, and analyse how interactions in these increasingly complex systems are governed and coordinated.

The rest of the paper is organised as follows. In Section 2 we introduce our new GVC metric by means of the iPod value chain study by Dedrick et al. (2010). We then present our mathematical approach that is based on Leontief's well-known decomposition technique. In Section 3, the construction of the WIOD database is discussed and data sources described. Results of the GVC decompositions are discussed in Section 4. Section 5 concludes.

2. Quantifying global value distributions

In this section we introduce our new global value chain (GVC) metric. We start with an example of a product GVC to illustrate the various concepts involved, based on the case study of Apple's iPod by Dedrick at al. (2010). The iPod example clearly illustrates the basic concept of a global value chain. Value is added at various stages of production through the utilisation of production factors labour and capital. Through the use of intermediate products, value added in previous stages is embodied in the value of the final product. It provides a clear illustration of how the final product value is distributed among the various firms and regions involved in production. To assess the contribution of a country to a chain both direct and indirect effects need to be taken into account. In section 2.2 we outline our proposal for such a measure. It is based on the measurement of embodied factor services from various countries in the value of final goods through the use of a world input-output table.

---

[2] See also de Backer and Yamano (2007). Foster and Stehrer (2010) provide a recent overview.

2.1 Global value distribution of an iPod

Dedrick et al. (2010) provide a detailed analysis of the various activities in the production of the so-called Video iPod, the 30GB version of Apple's fifth generation iPods. Their case study shows the strong global fragmentation of the production process of high-end electronic products in which intricate regional production networks feeding into each other. The lead firm in this production chain is Apple, a US multinational company, which has designed the iPod and organises its production. The iPod is manufactured in mainland China through assembling of several hundreds of components and parts. Based on professional industry sources, Linden et al. traced the origins and values of the various components and found that most of them, in particular the more expensive ones did not originate from China, but from other Asian countries and the US. Figure 1 shows how components are imported into China to be assembled into the iPod. This is subsequently exported to the warehouses of the lead firm Apple in the US, before being sold to final customers throughout the world through various distribution and retail channels. The main components of the iPod are the hard disc drive (HDD) and display from Japan, processors from the US and the memory from South Korea, alongside hundreds of other small components.

[Fig 1 about here]

Within a production chain, each participant purchases inputs and then adds value which becomes part of the cost for the next stage of production. The sum of the value added by all participants in the chain equals the final product price paid by the customer. This is indicated in two rows below the figure which indicate the price at a particular point in the production chain and the value added at a particular production stage (based on Table A2 from Dedrick et al. 2010 and Table 1 from Linden et al. 2009). The final consumer price of the iPod in the US is 299$. Of this, about 75$ is added by distribution and retailing services.[3] Apple, a US company, is estimated to capture about 79$ of each iPod. This is compensation for Apple's provision of software and designs, market knowledge, intellectual property, system integration and cost management skills and a high-value brand name. These are the results of investment in so-called intangible assets that are becoming increasingly important for growth in advanced nations (Corrado and Hulten, 2010). The ex-factory price of the iPod when shipped from China is about 145$. The value added in China through assembling is rather limited and estimated at around 4$

[3] In this case of US customers, this value is provided by mainly US wholesalers and retailers, but this value could also be captured by other countries in case the iPod is sold in other markets. In this paper we do not analyse the margins generated after the production of the final good, and focus instead on the distribution of the good's value as represented by its basic price value.

only.[4] The remainder of about 141$ represents cost to the Chinese assembler as high-value components have to be sourced from elsewhere. Based on estimated gross profit margins Linden et al. estimate that about 34$ of these costs are captured by the foreign firms in charge of manufacturing the ten most important components.

This case study shows clearly how value chains can be widely dispersed. It also indicates a problem of the case-study approach which is that indirect effects are difficult to take into account. The remainder of 107$ in cost of goods is left unaccounted for. Dedrick et al. (2010) indicate that some of the components are themselves the end-product of a global production chain. For example, the production chain of the iPod hard disc drive (HDD) is led by Toshiba, a Japanese firm, but assembly takes place in China and the Philippines, again based on components sourced from around the world. A proper decomposition of global values should also allow for these indirect contributions. These can be sizeable particularly in situations where production relies heavily on the use of imported intermediates. To analyse this we introduce our new GVC metric that includes both direct and indirect contributions to production based on a world input-output table.

2.2 A new GVC metric

Our aim is to decompose the value of a final product into the value added by various production factors in various regions in the world. The approach follows a standard insight from Leontief (1949) and traces the amount of factor inputs needed to produce a certain amount of final demand. The key element in this approach is that not only direct, but also indirect contributions are taken into account. The direct contribution is by labour and capital employed in the final stage of production that is in the industry delivering the so-called *final* product to the consumer. But the value of the product will also contain value added by factors employed in earlier stages of production. The size of these indirect effects depends on the interrelatedness of production across industries and countries.

The linkages between consumption, production and income are depicted in Figure 2. The arrows indicate flows of products and factors, which are mirrored by payments that flow in the opposite direction. The central link between income and consumption is the production process in which value is added through the deployment of labour and capital in production. Part of the payments of consumers in the domestic economy will end up as domestic factor income, but part will also flow to foreign factors of production. Similarly, domestic factor income will partly originate from consumers abroad. At the national level the two flows will not be equal. But at the global level they must equal by definition: global consumption is equal to global value added. Hence we can decompose global final expenditure flows into factor income streams worldwide.

[4] Linden et al. (2010) also show for some other high-end electronic products such as notebooks that the assembling done by Chinese factories captures at most 3 per cent of the ex-factory price.

The crucial link between the two flows is the production process. To take account of the interrelatedness of production across industries and countries, a world input-output table is needed. Variations of this approach are also used in the bourgeoning literature on trade in value added, e.g. Reimer (2006), Trefler and Zhu (2010) and Johnson and Noguera (2011). But rather than using Leontief's insight to analyse factor content of trade flows, we focus on analyses of global value distributions.

[Figure 2 about here]

More formally, let g=1,..,G index products, let i and j =1,.., N index countries and let f=1,..,F index production factors.[5] Every product is consumed as a final product and/or used as an intermediate input. Let Y_{ij} be a G x 1 vector denoting j's usage of intermediate inputs produced in country i. For all variables in this section with two subscripts, the first indicates the producer and the second the user. Country i's output Q_i is split between production for final consumption C_{ij} and for intermediate inputs:

$$Q_i \equiv \sum_j \left(C_{ij} + Y_{ij}\right) \qquad (1)$$

Let $B_{ij}(g,h)$ be the amount of intermediate input g used to produce one unit of good h, where g is made in country i and h is made in country j. Let $Q_j(h)$ be a typical element of Q_j. Then $B_{ij}(g,h)Q_j(h)$ is the amount of input g used to produce $Q_j(h)$ and $\Sigma_h B_{ij}(g,h) Q_j(h)$ is the amount of intermediate input g produced in country i and used by country j. Restated, $\Sigma_h B_{ij}(g,h)Q_j(h)$ is the gth element of Y_{ij}.

Country j's vector of imports from country i is defined by

$$M_{ij} \equiv C_{ij} + Y_{ij}, \quad j \neq i, \qquad (2)$$

and country i's exports to the world is

$$X_i \equiv \sum_{j \neq i} \left(C_{ij} + Y_{ij}\right). \qquad (3)$$

In a consistent framework, the exports of country i must equal the sum of all imports from country i:

$$X_i = \sum_j M_{ij} \qquad (4)$$

[5] We follow the convention of Trefler and Zhu (2010) to introduce matrix algebra only at a later stage to facilitate interpretation.

This completes the definition of the variables that we will use.

To decompose the value of products into the various value added parts, we will construct a regional input-output table of the world economy where each region is a country. This will allow us to track the movement of intermediate inputs both within and across countries. Let **B** be the world input-output matrix with intermediate input coefficients of dimension (NG x NG).

$$B \equiv \begin{bmatrix} B_{11} & B_{12} & \cdots & B_{1N} \\ B_{21} & B_{22} & \cdots & B_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ B_{N1} & B_{N2} & \cdots & B_{NN} \end{bmatrix}$$

where $\mathbf{B}_{ij}$ is the GxG matrix with typical elements $B_{ij}(g,h)$.[6] The matrix **B** describes how a given product in a country is produced with different combinations of intermediate products. The diagonal sub-matrices track the requirement for domestic intermediate inputs, while the off-diagonal elements track the requirements for foreign intermediate inputs.

We will also need the following NG x NG matrices:

$$Q \equiv \begin{bmatrix} diag\ Q_1 & 0 & \cdots & 0 \\ 0 & diag\ Q_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & diag\ Q_N \end{bmatrix}, \ C \equiv \begin{bmatrix} diag\ C_{11} & diag\ C_{21} & \cdots & diag\ C_{N1} \\ diag\ C_{12} & diag\ C_{22} & \cdots & diag\ C_{N2} \\ \vdots & \vdots & \ddots & \vdots \\ diag\ C_{1N} & diag\ C_{2N} & \cdots & diag\ C_{NN} \end{bmatrix}$$

where diag X indicates a diagonal matrix of vector X with the elements of X on the diagonal and zero's otherwise.

We will rely on the fundamental input-output identity introduced by Leontief (1949) which states that **Q=BQ+C** which can be written as $\mathbf{Q}=(\mathbf{I}-\mathbf{B})^{-1}\mathbf{C}$ with **I** an (NC x NC) identity matrix.[7] $(\mathbf{I}-\mathbf{B})^{-1}$ is famously known as the Leontief inverse. It represents the total production value that is – directly and indirectly – required to produce for final demand. To see this, let Z be a vector column with first element representing the global consumption of iPods produced in China, and the rest zero's. This is equal to the final output of the Chinese iPod industry. Then BZ is the vector of *direct* intermediate inputs, both Chinese and foreign, needed to assemble the iPods in China, such as the hard-disc

[6] Note that we use coefficients here, that is the B-elements are divided by gross output in the industry.
[7] See Miller and Blair (2009) for an introduction to input-output analysis.

drive, battery and processors. But these intermediates need to be produced as well. B^2Z indicates the intermediate inputs directly needed to produce BZ, and so on. Thus $\sum_{n=2}^{\infty} B^n Z$ represents all intermediate inputs indirectly needed. By adding the final output to all direct and indirect intermediate input requirements, the total gross output value related to the production of a unit of final output Z is given by $Z + BZ + \sum_{n=2}^{\infty} B^n Z = \sum_{n=0}^{\infty} B^n Z = (I - B)^{-1} Z$.

Using this identity, we can derive production factor requirements for any vector Z. We define matrix **F** as the direct factor inputs per unit of *gross output* with dimension FN x NG. This matrix considers country- and industry-specific direct factor inputs. An element in this matrix indicates the share in the value of gross output of a production factor used directly by the country to produce a given product, for example the value of low-skilled labour used in the Chinese electronics industry to produce one dollar of output. The elements in **F** are direct factor inputs in the industry, because they do not account for production factors embodied in intermediate inputs used by this industry. For the latter we need to define a matrix **A** (FN x NG) as follows:

$$A = F(I - B)^{-1} \qquad (5)$$

where **A** is the matrix of factor inputs required per unit of final demand. Note that **A** includes both direct and indirect factor inputs, and contains coefficients. The *amounts* of factor inputs that can be attributed to observed levels of final demand can then be found by using the expression

$$K = AC \qquad (6)$$

in which **K** is the (FN x NG) matrix of amounts of factor inputs attributed to each of the NG final demand levels. Each column of K provides the domestic and foreign factor inputs needed for the production of final output of a particular good *g* in country *j*. A typical element in K indicates the amount of a production factor *f* from country *i*, embodied in final output of *g* in country *j*. By the logic of Leontief's insight, the sum of all elements in a column will be equal to the final output of this product. Thus we have completed our decomposition of the value of final output into the value added by various production factors around the world.

For various applications we are also interested in amounts of factors associated with specific subgroups of final demand, such as final demand for world electronics, final demand for Dutch products or final domestic demand in Germany. In these cases we modify **C** by setting all values to zero, except for the final demand flows of interest.

Our GVC metric is akin to the measure of vertical specialisation (VS) introduced by Hummels, Ishii and Yi (2001). They proposed to measure the degree of international integration of production in a country by the share of imported intermediate inputs over gross output. This measure basically presumes a production process of maximum two stages such that any good exported by a country is a final good, or will never be used by any other country (directly or indirectly) to produce exports destined for that country. However, in reality production processes are organised as interacting networks, and exports of intermediate goods is extensive. As a result, the VS measure suffers from various double counting problems and is not consistent defined across industries and countries. Johnson and Noguera (2011) propose a new measure defined as a value added to export ratio measured within a global input-output framework that remedies the double counting problem at the country level and show that differences can be sizeable.

Our GVC measure takes an additional step to be also globally consistent, that is, there is a complete decomposition of value added world-wide. This can only be achieved by focusing on value of final output as at the global level total value added created in all countries has to equal final domestic demand from all countries. While at the country level total value added is equal to domestic demand plus exports minus imports, the latter two cancel out at the global level. A decomposition starting from exports as in Johnson and Noguera (2011) will still suffer from double counting problems as the measures cannot be aggregated across countries. In addition, we provide a further breakdown of value added into the contributions of various types of labour and capital. This is important given the expected differential effects of outsourcing and off-shoring on various production factors such as low-skilled labour.

3. Data construction

To implement the new GVC metric, one needs to have a database with linked consumption, production and income flows within and between countries. For individual countries, this type of information can be found in input-output tables. However, national tables do not provide any information on bilateral flows of goods and services between countries. For this type of information researchers have to rely on datasets constructed on the basis of national input-output tables in combination with international trade data. Various alternative datasets have been built in the past of which the GTAP database is the most widely known and used (Narayanan and Walmsley, 2008). Other datasets are constructed by the OECD (Yamano and Ahmad 2006) and IDE-JETRO (2006). However, all these databases provide only one or a limited number of benchmark year input-output tables which preclude an analysis of developments over time. And although they provide separate import matrices, there is no detailed break-down of imports by trade partner. For

this paper we use a new database called the World Input-Output Database (WIOD) that aims to fill this gap. The WIOD provides a time-series of world input-output tables from 1995 onwards, distinguishing between 35 industries and 59 product groups. Using a novel approach national input-output tables of forty major countries in the world are linked through international trade statistics, covering more than 85 per cent of world GDP. The construction of the world input-output tables will be discussed in section 3.1.

Another crucial element for this type of analysis are detailed value-added accounts that provide information on the use of various types of labour (distinguished by educational attainment level) and capital in production, both in quantities and values. While this type of data is available for most OECD countries (O'Mahony and Timmer, 2009), it is not for most developing countries. In Section 3.2 we describe our data strategy, with a particular emphasis for the Chinese data that is most important for the topic of this paper, but at the same time the most challenging.

3.1 World Input-Output Tables (WIOTs): concepts and construction

In this section we outline the basic concepts and construction of our world input-output tables. Basically, a world input-output table (WIOT) is a combination of national input-output tables in which the use of products is broken down according to their origin. In contrast to the national input-output tables, this information is made explicit in the WIOT. For each country, flows of products both for intermediate and final use are split into domestically produced or imported. In addition, the WIOT shows for imports in which foreign *industry* the product was produced. This is illustrated by the schematic outline for a WIOT in Figure 2. It illustrates the simple case of three regions: countries A and B, and the rest of the world. In WIOD we will distinguish 40 countries and the rest of the World, but the basic outline remains the same.

[Figure 3 about here]

The rows in the WIOT indicate the use of output from a particular industry in a country. This can be intermediate use in the country itself (use of domestic output) or by other countries, in which case it is exported. Output can also be for final use[8], either by the country itself (final use of domestic output) or by other countries, in which case it is exported. Final use is indicated in the right part of the table, and this information can be used to measure the C matrix defined in section 2. The sum over all uses is equal to the output of the industry, denoted by Q in section 2.

A fundamental accounting identity is that total use of output in a row equals total output of the same industry as indicated in the respective column in the left-hand part of

[8] Final use includes consumption by households, government and non-profit organisations, and gross capital formation.

the figure. The columns convey information on the technology of production as they indicate the amounts of intermediate and factor inputs needed for production. The intermediates can be sourced from domestic industries or imported. This is the B matrix from section 2. The residual between total output and total intermediate inputs is value added. This is made up by compensation for production factors. It is the direct contribution of domestic factors to output. We prepare the F matrix from section 2 on this information after breaking out the compensation of various factor inputs as described in Section 3.2.

As building blocks for the WIOT, we will use national supply and use tables (SUTs) that are the core statistical sources from which NSIs derive national input-output tables. In short, we derive time series of national SUTs and link these across countries through detailed international trade statistics to create so-called international SUTs. These international SUTs are used to construct the symmetric world input-output. The construction of our WIOT has a number of distinct characteristics.

We rely on national supply and use tables (SUTs) rather than input-output tables as our basic building blocks. SUTs are a natural starting point for this type of analysis as they provide information on both products and industries. A supply table provides information on products produced by each domestic industry and a use table indicates the use of each product by an industry or final user. The linking with international trade data, that is product based, and factor use that is industry-based, can be naturally made in a SUT framework.[9]

To ensure meaningful analysis over time, we start from industry output and final consumption series given in the national accounts and benchmark national SUTs to these time-consistent series. Typically, SUTs are only available for a limited set of years (e.g. every 5 year)[10] and once released by the national statistical institute revisions are rare. This compromises the consistency and comparability of these tables over time as statistical systems develop, new methodologies and accounting rules are used, classification schemes change and new data becomes available. By benchmarking the SUTs on consistent time series from the National Accounting System (NAS), tables can be linked over time in a meaningful way. This is done by using a SUT updating method (the SUT-RAS method) as described in Temurshoev and Timmer (2011) which is akin to the well-known bi-proportional (RAS) updating method for input-output tables. For this updating data on gross output and value added by industry is used, alongside data on final expenditure categories from the National Accounts.

Ideally, we would like to use official data on the destination of imported goods and services. But in most countries these flows are not tracked by statistical agencies. Nevertheless, most do publish an import IO table constructed with the import

[9] As industries also have secondary production a simple mapping of industries and products is not feasible.

[10] Though recently, most countries in the European Union have moved to the publication of annual SUTs.

proportionality assumption, applying a product's economy-wide import share for all use categories. For the US it has been found that this assumption can be rather misleading in particular at the industry-level (Feenstra and Jensen, 2009; Strassner, Yuskavage and Lee, 2009). Therefore we are not using the official import matrices but use detailed trade data to make a split. Our basic data is bilateral import flows of all countries covered in WIOD from all partners in the world at the HS6-digit product level taken from the UN COMTRADE database. Based on the detailed description products are allocated to three use categories: intermediates, final consumption, and investment, effectively extending the UN Broad Economic Categories (BEC) classification. We find that import proportions differ widely across use categories and importantly, also across country of origin. For example, imports by the Czech car industry from Germany contain a much higher share of intermediates than imports from Japan. This type of information is reflected in our WIOT by using detailed bilateral trade data. The domestic use matrix is derived as total use minus imports.

Another novel element in the WIOT is the use of data on trade in services. As yet no standardised database on bilateral service flows exists. These have been collected from various sources (including OECD, Eurostat, IMF and WTO), checked for consistence and integrated into a bilateral service trade database (see Stehrer et al., 2010, for details). Although the maximum of existing information is used, there are clear gaps in our knowledge in particular at a low level of aggregation.

Based on the national SUTs, National account series and international trade data, international SUTs are prepared for each country. As a final step, international SUTs are transformed into an industry-by-industry type world input-output table. We use the so-called "fixed product-sales structure" assumption stating that each product has its own specific sales structure irrespective of the industry where it is produced (see e.g. Eurostat, 2008). For a more elaborate discussion of construction methods, practical implementation and detailed sources of the WIOT, see the Data appendix.

3.2 Factor input requirements

For factor input requirements we collected country-specific data on detailed labour and capital inputs for all 35 industries. This includes data on hours worked and compensation for three labour types (low-, medium- and high-skilled labour) and data on capital stocks and compensation. These series are not part of the core set of national accounts statistics reported by NSIs; at best only total hours worked and wages by industry are available from the National Accounts. Additional material has been collected from employment and labour force statistics. For each country covered, a choice was made of the best statistical source for consistent wage and employment data at the industry level. In most countries this was the labour force survey (LFS). In most cases this needed to be

combined with an earnings surveys as information wages are often not included in the LFS. In other instances, an establishment survey, or social-security database was used. Care has been taken to arrive at series which are time consistent, as most employment surveys are not designed to track developments over time, and breaks in methodology or coverage frequently occur.

Labour compensation of self-employed is not registered in the National Accounts, which as emphasised by Krueger (1999) leads to an understatement of labour's share. This is particularly important for less advanced economies that typically feature a large share of self-employed workers in industries like agriculture, trade, business and personal services. We make an imputation by assuming that the compensation per hour of self-employed is equal to the compensation per hour of employees. Capital compensation is derived as gross value added minus labour compensation as defined above.

For most OECD countries labour data was taken from the EU KLEMS database (www.euklems.org, described in O'Mahony and Timmer 2009). For other countries additional data has been collected, which is described in full in Erumban et al. (2011). Here we discuss the sources for China, being the most important country for our analysis and one for which labour data is particularly scarce.

The main data source for relative wages by educational attainment and broad sectors of the economy for China are from the China Household Income Project (CHIP) survey, 2002. The CHIP study is considered the best available data source on household income and expenditures and the only available source for wage data by educational attainment. The CHIP survey is split into an urban and a rural survey. These two surveys were combined, resulting in about 18,500 observations on wages per hour, level of education, and broad sector of activity (after cleaning the dataset by dropping the 1st and 99th percentile of wage per hour). The broad sectors distinguished are agriculture, other industries, manufacturing, transport, storage and communication, distributive trade, other market services, and government services. The yearly wage from work is measured as the sum of total income, subsidy for minimum living standard, living hardship subsidies from work unit, and monetary value of income in kind. We distinguish three classes:

- Low-skilled: Never schooled; Classes for eliminating illiteracy; Elementary school; and Junior middle school
- Medium-skilled: Senior middle school (including professional middle school) and Technical secondary school
- High-skilled: Junior college; College/University; Graduate

4. Global Value Chain Decompositions

In this section, we explore trends in the distributions of value in global production chains using the decompositions introduced in Section 2. We start by studying the degree of vertical integration between countries in the spirit of Hummels et al. (2001) through an analysis of shares of foreign value added in domestic manufacturing. Then we extend the analysis by linking explicitly changes in global demand to changes in the remuneration of production factors around the world. Throughout this section, the concept of a "country's value chain" indicates the value of all activities (domestically and abroad) that are needed to generate final products in the country's manufacturing sector. It is not indicative of ownership or governance in the chain in any sense, but is identified by the location of the final stage of production. So while say Apple governs the production of the iPods, it is called a Chinese value chain in this study as the final assembly takes place in China. We will return to the ownership issue at the end of this section.

For each of the forty countries in our dataset we calculate the share of foreign value added in final output of the domestic manufacturing. As a first step, we investigate the distribution of value across major country groups before looking at country-level trends. We distinguish China and five groups of countries, namely the European Union (EU) consisting of the 27 EU member states; NAFTA consisting of Canada, Mexico and the US; East Asia consisting of Japan, South Korea and Taiwan; BRIIAT consisting of Brazil, Russia, India, Indonesia, Australia and Turkey; and Rest of the World consisting of all countries not covered individually in the world input-output database but for which an estimate has been made as a group (see section 3). In some tables BRIAAT and Rest of World have been clubbed as "Others".

Table 1 provides the share of these groups in the final manufacturing output of a particular region in 1995 and 2006. As expected most of the value added is generated within the region itself. In 1995, 89% of the EU value was added in the EU itself and 91% in NAFTA. But own-region shares have been declining over the period from 1995 to 2006, while the shares of China and of Others in foreign value have been steadily increasing. Through the increased delivery of intermediates these regions capture a larger share of manufacturing value chains elsewhere. But in turn, these regions also loose value in their domestic chains. The foreign share in China has increased from 14 per cent in 1995 to 21 per cent in 2006. Historically East Asia holds a large part of this, but the main increase came from the Others region.

[Table 1 about here]

The increase in foreign shares across regional blocs can also be found across countries within a block. Figure 3 provides for forty individual countries the foreign shares in 1995

and in 2006, ranked from highest to lowest share in 2006. For all countries, with the exception of Latvia and Canada, the foreign share increased during this period. This increase was concentrated mainly within the region, but not exclusively, as can be seen from Table 2. The first two columns in this table provide the domestic shares for 1995 and 2006. The next columns provide a decomposition of the foreign share into the region of origin. The final two columns indicate the final manufacturing output of each country in million US$ (based on exchange rate conversion). The foreign share varies greatly across countries and is clearly related to the size of the economy, which was also found by Hummels et al. (2001). It is particularly high in small European economies. In 2006, the foreign share in Estonia, Slovak Republic, Belgium, Hungary, Ireland and Lithuania was higher than 50 % and mostly originated from the European Union, although the Baltic States also traded heavily with Russia, and a major part of Ireland's value is added in NAFTA rather than the EU. Integration of Canada, Mexico and the US within NAFTA was already high in 1995 and did not change much in the period after. In Asia, there is a clear two-way integration between Japan, South Korea and Taiwan on the one hand and China on the other. In particular Chinese shares in East Asian chains increased rapidly, albeit from a low level. All in all, these results point to a general trend towards stronger integration of production across countries both within and across regional trading blocs.

[Table 2 about here]
[Figure 4 about here]

While a study of changing shares at the country level is insightful for an analysis of integration across countries, it is silent on the movements in value added due to changes in the *levels* of global final demand. It is the change in levels though which is important when considering the impact of integration across countries on the distribution of factor incomes. Increasing foreign penetration in an economy with stagnant demand for its output will lead to a hollowing out of income for domestic factors of production. In a growing economy on the other hand, increasing foreign shares might not "compete" with domestic capital and labour. Although the foreign penetration in Chinese manufacturing increased, the amount of value added by Chinese factors of production increased at the same time as demand for Chinese manufacturing output increased rapidly, both domestically and abroad. In addition, we found above that China increased its share in other countries' value chains tapping into another source of income growth. To analyse the net effects of all these changes, the foreign and domestic shares found above in Table 2 need to be multiplied by the respective values of final output in each country. The results for the major regions are given in Table 3.

Table 3 indicates the regional distribution of value added related to the consumption of manufacturing goods worldwide in 1995 and 2006.[11] The first two columns are in constant 1995 US$ (using exchange rates and the US CPI for deflation), while the last two columns indicate shares in the world total.[12] Overall, of the worldwide expenditure on final manufacturing products, China is capturing about 11% in 2006, up from 5% in 1995. The shares of the EU and NAFTA declined somewhat, but the major loss is in East Asia (see also Figure 5). While South Korea and Taiwan are still increasing their shares, the income share of Japan in global manufacturing expenditure has been declining rapidly. Japanese manufacturing production declined and a larger share of its value was captured by China and other Asian countries. This was not compensated for by increasing Japanese income in foreign value chains.

[Table 3 about here]
[Figure 5 about here]

Our income data on labour and capital allows us to study which production factors have benefitted from the changes in the regional distribution of global value added. Increasing trade and integration of world markets has been related to increasing unemployment and stagnating relative wages of low- and medium-skilled workers in developed regions. On the other hand, it offered new opportunities for developing regions to employ their large supply of low-skilled workers. To study these trends, we decomposed value added into four parts: income for capital and income for labour, split into low-, medium- and high-skilled labour. High-skilled labour is defined as workers with college degree or above. Medium skilled workers have secondary schooling and above, including professional qualifications, but below college degree, and low-skilled have below secondary schooling. The income for capital is the amount of value added that remains after subtracting labour compensation. It is the gross compensation for capital, including profits and depreciation allowances. Being a residual measure it is the remuneration for capital in the broadest sense, including tangible, intangible and financial capital. Table 4 provides the levels in constant US$ and also shares in world total. The latter are also depicted in Figure 6 for each of the four production factors.

---

[11] Consumption refers to final expenditure, including consumption by households and governments as well as investment flows.

[12] Note that the numbers for each region are not equal to manufacturing value added in that region, but to value added related to the production of final manufacturing goods. Manufacturing production entails the use of non-manufacturing intermediates such as raw materials, energy and business services. The value added generated in the production of these intermediates is included as well. Similarly, some value added in manufacturing is in the production of intermediates consumed in other sectors and might end up in the final consumption of non-manufacturing goods. This "leakage" of manufacturing value added is typically smaller than the "crowd in" from other sectors.

Between 1995 and 2006, the income for labour related to global manufacturing consumption increased worldwide, mainly due to a strong increase in the remuneration of high-skilled workers. These workers gained all around the world except in East Asia. Increases were particularly strong in NAFTA and the EU. In contrast, worldwide remuneration of medium-skilled workers declined. Strong increases in China did not offset the losses in NAFTA and in particularly in East Asia. As expected, income for low-skilled workers increased strongly in China and in other developing economies, while declining in NAFTA, EU and East Asia. Note that we measure the total wage bill for workers and not the wage level per worker, so that an decline in the value might be due to a decline in employment and/or in wages. Worldwide, medium- and low-skilled workers are losing out on high-skilled workers and capital as shares of the latter in value added are increasing. Compensation for capital input has gone up around the world, except in East Asia. Its increase has been particularly strong in China and BRIIAT, which might be related to the low wage-rental ratios in these regions that were still characterised by a abundant surplus of low-skilled workers. But also within NAFTA capital compensation shares increased.

It should be stressed that the country dimension in the GVC analysis is based on location of production and not on ownership of production factors. It provides the share captured by capital and labour employed in a particular country, but is silent on ownership. In the case of labour income, this is relative unproblematic as for most countries cross-border labour migration is relatively minor. Hence labour income paid out in a particular industry mostly benefits the workers of the country in which production takes place. This is less clear for capital income. For example, many Chinese textile factories are owned by non-Chinese, and a sizeable part of capital income might end up in foreign hands. The extent of this will depend on the importance of foreign. Work is currently on going in the WIOD-project to estimate the foreign ownership shares in capital.

[Table 4 about here]
[Figure 6 about here]

In a final decomposition we break down the value added related to global final manufacturing expenditure by sector of origin. We distinguish resource industries including agriculture, mining, wood manufacturing, non-metallic minerals manufacturing and oil refining; Manufacturing including other manufacturing industries; and Services including all other industries.

Table 5 shows that only slightly more than 50 per cent of expenditure value on manufacturing products is added by factors employed in manufacturing industries. Around one-third originates from labour and capital in services industries and the remainder from the resource sector. These shares have changed over time however, with

a declining share for manufacturing factors, and increasing shares for services and resources. Especially the BRIIAT and the Other regions contribute to manufacturing output through delivery of natural resources. With a steady increase in natural resource prices, the shares increased rapidly since 1995. China added value mainly through increasing factor employment in the manufacturing sector. In contrast, in NAFTA and the EU value was increasingly added through the services sector (see Figure 7). This might be related to the phenomenon of outsourcing of services activities from manufacturing firms to services firms. A similar trend is to be seen in East Asia, as the declining contribution of East Asian manufacturing is much stronger than from its services sector.

[Table 5 about here]
[Figure 7 about here]

5. Concluding remarks

A global value chain perspective has profound implications for one's thinking of competitiveness and growth. It highlights the importance of global production networks and the increasing interrelation of consumption, production and income across national boundaries through the trade of goods and services. Increasingly a country's competitiveness and growth is about capturing larger share of global value chains, in particular in products for which global demand is growing (Porter 1990). In this paper we proposed a new metric that is based on analysis of vertically integrated industries both within and across countries. This metric traces the origin of a region's factor income to demand for manufacturing products worldwide. We applied this metric to a newly developed database called WIOD that contains a World Input-Output Table and a set of industry-and-country specific labour and capital income shares. Two main conclusions stand out.

First, our results point to a general trend towards stronger integration of production across countries both within and across regional trading blocs. We found that in 38 out of the 40 countries the degree of global vertical integration has increased over the period from 1995 to 2006. Foreign production factors increasingly contributed to the value of final manufacturing output. In small countries this can be up to 50 per cent. But also in large countries like France, Germany, Japan and the US shares are up to 15%. In China the foreign share increased from 14 per cent in 1995 to 21 per cent in 2006. This is captured mostly by East Asia and other non-OECD countries.

Second, we found strong trends in the shares of various regions in the value of worldwide expenditure on manufacturing products. Importantly, China was capturing about 11% in 2006, up from 5% in 1995, mainly at the expense of Japan. The shares of value added by the EU and NAFTA declined only slightly. These trends were uneven for

the various factors of production. On a global scale, medium- and low-skilled workers are losing out on high-skilled workers and capital, as value-added shares of the latter are increasing. Compensation for high-skilled workers and capital has gone up around the world, in particular in the EU and NAFTA. In China and other developing regions low-skilled workers increased their shares in global value added, but the biggest increases in compensation were for medium-skilled workers and capital.

Clearly, the validity of the findings in this paper relies heavily on the quality of the databases used. The WIOD has been constructed with the aim of making maximum use of the publicly available data on national input-output tables, international trade statistics and production factor incomes. In the process of consolidating these separate databases, inconsistencies have been found and compromises made to arrive at an internally consistent World Input-Output table. For example, the well-known inconsistency between mirror trade flows in the COMTRADE data was resolved by focusing on import flows only. Other issues relate to re-exports of goods and trade in services that are not very well reflected in today's trade statistics. We gave priority to data on exports and import of goods and services from national supply and use tables that provide additional detail. Also, it is notoriously hard to determine the use category of imports. Instead of applying row-proportionality, we relied on applying a new BEC classification at a detailed 6-digit level to estimate intermediate and final use shares of imports. Nevertheless, it is clear that present day statistical systems are lagging behind the developments in today's world. In particular, trade in intangibles such as royalties and licences is still poorly reflected and measurement of import price indices needs to be improved (see e.g. Feenstra et al. 2010; Houseman and Ryder, 2010).

As a final note, we would like to stress that the results in this paper are preliminary. They are based on the world input-output database (WIOD) that is currently under development. In the upcoming year this database will be further improved, in particular by improving the estimates of international trade in services. Also, the data will be updated to 2009. The data will be made public by May 2012, free of charge through our website www.wiod.net. Although the results are still preliminary, we hope that the paper illustrated the usefulness of a global value chain metric in analysing the trends in global consumption, trade, production and incomes.

References

Ali-Yrkkö, Jyrki, Petri Rouvinen, Timo Seppälä and Pekka Ylä-Anttila (2011), *Who Captures Value in Global Supply Chains?*, ETLA Discussion Papers, No 1240, ETLA: Helsinki.

Backer, K. De & Norihiko Yamano (2007). "The Measurement of Globalisation using International Input-Output Tables," OECD STI Working Papers 2007/8, OECD, Directorate for Science, Technology and Industry.

Baldwin, Richard E. (2006), "Globalisation: The Great Unbundling(s)", in *Globalisation Challenges for Europe*, Helsinki: Office of the Prime Minister of Finland.

Corrado, Carol A., and Charles R. Hulten. 2010. "How Do You Measure a "Technological Revolution"?" *American Economic Review*, 100(2): 99–104.

Dedrick, J., K.L.Kraemer and G. Linden (2010), "Who Profits From Innovation in Global Value Chains? A Study of the iPod And Notebook PCs", *Industrial and Corporate Change*, 19 (1): 81-116.

Eurostat (2008) *Handbook of Supply, Use and Input-Output Tables*, Eurostat.

Erumban, A.A., F.R. Gouma, G. de Vries and M.P. Timmer (2011), *Construction of Socio-Economic Accounts for the WIOD*, GGDC Groningen, in preparation.

Feenstra, R.C. and J. Bradford Jensen (2009), *Evaluating Estimates of Materials Offshoring from U.S. Manufacturing*, draft October 2009.

Feenstra, R., Robert Lipsey and others (2010), "Report on the State of Available Data for the Study of International Trade and Foreign Direct Investment", NBER Working Paper 16254, NBER.

Feenstra, R. and C. Hong (2010), "China's Exports and Employment" in Robert C. Feenstra and Shang-Jin Wei (eds), *China's Growing Role in World Trade*, pp. 167-199, NBER, University of Chicago Press

Foster, N. and R. Stehrer (2010), The Factor Content of Trade: A Survey of the Literature, WIOD Deliverable 8.1.

Gereffi, G. (1999), 'International Trade and Industrial Upgrading in the Apparel Commodity Chain', *Journal of International Economics*, 48(1), pp.37–70

Gou, D & Colin Webb & Norihiko Yamano (2009) "Towards Harmonised Bilateral Trade Data for Inter-Country Input-Output Analyses: Statistical Issues," OECD STI Working Papers 2009/4, OECD, Directorate for Science, Technology and Industry.

Grossman, Gene M. and Rossi-Hansberg, Esteban (2008), "Trading Tasks: A Simple Theory of Offshoring", *American Economic Review* 98:5, 1978-1997.

Houseman, Susan N., and Kenneth F. Ryder, Jr. (2010), "Measurement Issues Arising from the Growth of Globalization: Conference Summary.", *Report prepared for the W.E. Upjohn Institute for Employment Research and the National Academy of Public Administration*.

Hummels, David & Ishii, Jun & Yi, Kei-Mu (2001), "The nature and growth of vertical specialization in world trade," *Journal of International Economics*, vol. 54(1), pp. 75-96

IDE-JETRO (2006), Asian International Input-Output Table 2000, IDE-JETRO, Tokyo Japan.

Johnson, R. C. and G. Noguera (2011). *Accounting for Intermediates: Production Sharing and Trade in Value Added*. Mimeo May 2011.

Kaplinsky, R. (2000), "Globalisation and Unequalisation: What Can Be Learned from Value Chain Analysis?", *Journal of Development Studies*, 37(2), pp. 117 – 146

Krueger, A. B. (1999). 'Measuring Labor's Share.' *American Economic Review, Papers and Proceedings*, vol. 89 (2), pp.45-51.

Krugman, P. (1995), "Growing World Trade: Causes and Consequences", *Brookings Papers on Economic Activity* 1:1995

Krugman, P. (2008), "Trade and Wages, Reconsidered", *Brookings Papers on Economic Activity* 2008(1), pp. 103-154

Linden, G, J. Dedrick, and K.L. Kraemer (2009), "Innovation and Job Creation in a Global Economy: The Case of Apple's iPod", Working Paper, Personal Computing Industry Center, UC Irvine.

Miller, R.E. and P.D. Blair (2009), *Input-output Analysis: Foundations and Extensions*, Cambridge University Press.

Narayanan G. B. and Terrie L. Walmsley (eds, 2008), *Global Trade, Assistance, and Production: The GTAP 7 Data Base*, Center for Global Trade Analysis, Purdue University.

O'Mahony, M. and M.P. Timmer (2009), "Output, Input and Productivity Measures at the Industry Level: the EU KLEMS Database" *Economic Journal* 119(538), pp. F374-F403.

Porter, M.E. (1990), *The Competitive Advantage of Nations*, Free Press.

Reimer, J. (2006). Global Production Sharing and Trade in Services of Factors. *Journal of International Economics*, vol. 68, pp. 384-408.

Stehrer, R., et al. (2010), *Construction of Bilateral trade in goods and services for the WIOD*, WIIW, Vienna.

Strassner, E., Robert Yuskavage and Jennifer Lee (2009), *Imported Inputs and Industry Contributions to Economic Growth: An Assessment of Alternative Approaches*, Paper prepared for the NAPA/UpJohn Conference on Measurement Issues Arising from the Growth of Globalization Washington, DC, November 6-7, 2009.

Sturgeon, T., J. Van Biesebroeck and G. Gereffi (2008), "Value chains, networks and clusters: reframing the global automotive industry", *Journal of Economic Geography* (2008), pp. 1–25.

Trefler, D. and S. C. Zhu (2010), "The Structure of Factor Content Predictions", *Journal of International Economics*, Volume 82(2), pp. 195-207

Temurshoev, U. and M.P. Timmer (2011), "Joint estimation of supply and use tables", published online in *Papers in Regional Science* , DOI: 10.1111/j.1435-5957.2010.00345.x

Yamano, N. and N. Ahmad (2006), *The OECD Input-Output Database: 2006 Edition*, STI Working Paper 2006/8, Paris: OECD.

Data Appendix: Construction of the World Input-Output Table

In this section we outline the construction of the WIOT and discuss the underlying data sources. As building blocks we will use national supply and use tables (SUTs) that are the core statistical sources from which NSIs derive national input-output tables. In short, we derive time series of national SUTs and link these across countries through detailed international trade statistics to create so-called international SUTs. These international SUTs are used to construct the symmetric world input-output table.

Three types of data are being used in the process, namely national accounts statistics (NAS), supply-use tables (SUTs) and international trade statistics (ITS). Importantly, this data must be publicly available such that users of the WIOT are able to trace the steps made in the construction process. Moreover, official published data is more reliable as checking and validation procedures at NSIs are more thorough than for data that is ad-hoc generated for specific research purposes. The data is being harmonised in terms of industry- and product-classifications both across time and across countries. The WIOD classification list has 59 products and 35 industries based on the CPA and NACE rev 1 (ISIC rev 2) classifications. The product and industry lists are given in Appendix Tables 1 and 2. This level of detail has been chosen on the basis of initial data-availability exploration and ensures a maximum of detail without the need for additional information that is not generated in the system of national accounts. The 35-industry list is identical to the list used in the EUKLEMS database with additional breakdown of the transport sector as these industries are important in linking trade across countries and in the transformation to alternative price concepts (from purchasers' to basic prices, see below).[13] Hence WIOD can be easily linked to additional variables on investment, labour and productivity in the EU KLEMS database (see www.euklems.net, O'Mahony and Timmer, 2009). The product list is based on the level of detail typically found in SUTs produced by European NSIs, following Eurostat regulations and is more detailed than the industry list. It is well-known that non-survey methods to split up a use table into imported and domestic, such as used in WIOD, are best applied at a high level of product detail.

In Appendix Table 1 we provide an overview of the SUTs used in WIOD. For some countries full time-series of SUTs are available, but for most countries only some or even one year is available. This is indicated in the table. In some cases SUTs for a particular year were available, but have not been used as they contained too many errors or inconsistencies to be useful. Also, for some non-EU countries SUTs are not available, but only IOTs. For these countries a transformation from IOT to SUT has been made by assuming a diagonal supply table at the product and industry level of the original national

[13] In addition, in WIOD the EUKLEMS industry 17-19 is split into textiles and wearing apparel (17-18) and footwear (19) because of the large amount of international trade in these industries.

table which is often more detailed than the WIOD list. Appendix Table 1 provides details about the size of the original SUTs and IOTs and their price concept. The tables have been sourced from publicly available data from National Statistical Institutes and for many EU countries from the Eurostat input-output database.[14] To arrive at a common classification, correspondence tables have been made for each national SUT bridging the level of detail and classifications in the country to the WIOD classification. This involved aggregation and sometimes disaggregation based on additional detailed data. While for most European countries this was relatively straightforward, tables for non-EU countries proved more difficult. National SUTs were also checked for consistency and adjusted to common concepts (e.g. regarding the treatment of FISIM and purchases abroad). Undisclosed cells due to confidentiality concerns were imputed based on additional information. The adjustments and harmonisation are described in more detail on a country-by-country basis in Erumban et al. (2011).

In the first step of our construction process we benchmark the national SUTs to time-series of industrial output and final use from national account statistics. In Figure 3 a schematic representation of a national SUT is given. Compared to an IOT, the SUT contains additional information on the domestic origin of products. In addition to the imports, the supply columns in the left-hand side of the table indicate the value of each product produced by domestic industries. The upper rows of the SUT indicate the use of each product. Note that a SUT is not necessarily square with the number of industries equal to the number of products, as it does not require that each industry produces one unique product only. A SUT must obey two basic accounting identities: for each product total supply must equal total use, and for each industry the total value of inputs (including intermediate products, labour and capital) must equal total output value.

Supply of products can either be from domestic production or from imports. Let *S* denote supply and *M* imports, subscripts *i* and *j* denote products and industries and superscripts *D* and *M* denote domestically produced and imported products respectively. Then total supply for each product i is given by the summation of domestic supply and imports:

$$S_i = \sum_j S_{i,j}^D + M_i \qquad (1)$$

Total use (*U*) is given be the summation of final domestic use (*F*), exports (*E*) and intermediate use (*I*) such that

$$U_i = F_i + E_i + \sum_j I_{i,j} \quad (2)$$

The identity of supply and use is then given by

$$F_i + E_i + \sum_j I_{i,j} = \sum_j S_{i,j}^D + M_i \qquad \forall i \qquad (3)$$

[14] These can be found at http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/introduction.

The second accounting identity can be written as follows

$$\sum_i S^D_{i,j} = VA_j + \sum_i I_{i,j} \qquad \forall j \qquad (4)$$

This identity indicates that for each industry the total value of output (at left hand side) is equal to the total value of inputs (right hand side). The latter is given by the sum of value added (VA) and intermediate use of products.

Typically, SUTs are only available for a limited set of years (e.g. every 5 year) [15] and once released by the national statistical institute revisions are rare. This compromises the consistency and comparability of these tables over time as statistical systems develop, new methodologies and accounting rules are used, classification schemes change and new data becomes available. These revisions can be substantial especially at a detailed industry level. Therefore they are benchmarked on consistent time-series from the NAS in a second step. Data was collected for the following series: total exports, total imports, gross output at basic prices by 35 industries, total use of intermediates by 35 industries, final expenditure at purchasers' prices (private and government consumption and investment), and total changes in inventories. This data is available from National Statistical Institutes and OECD and UN National Accounts statistics. National SUTs are in national currencies and need to be put on a common basis for the WIOT. This is done by using official exchange rates from IMF. This data is used to generate time series of SUTs using the so-called SUT-RAS method (Temurshoev and Timmer 2011). This method is akin to the well-known bi-proportional updating method for input-output tables known as the RAS-technique. This technique has been adapted for updating SUTs.

Timeseries of SUTs are derived for two price concepts: basic prices and purchasers' prices. Basic price tables reflect the costs of all elements inherent in production borne by the producer, whereas purchasers' price tables reflect the amount paid by the purchaser. The difference between the two is the trade and transportation margins and net taxes. Both price concepts have their use for analysis depending on the type of research question. Supply tables are always at basic price and often have additional information on margins and net taxes by product. The use table is typically at a purchasers' price basis and hence needs to be transformed to a basic price table. The difference between the two tables is given in the so-called valuation matrices (Eurostat 2008, Chapter 6). These matrices are typically not available from public data sources and hence need to be estimated. In WIOD we distinguish 4 types of margins: automotive trade, wholesale trade, retail trade and transport margins. The distribution of each margin type varies widely over the purchasing users and we use this information to improve our estimates of basic price tables, see Erumban et al. (2011) for more detail.

In a second step, the national SUTs are combined with information from international trade statistics to construct what we call international SUTs. Basically, a

[15] Though recently, most countries in the European Union have moved to the publication of annual SUTs.

split is made between use of products that were domestically produced and those that were imported, such that

$$I_{i,j} = I^D_{i,j} + I^M_{i,j} \quad \forall i, j$$
$$F_i = F_i^D + F_i^M \quad \forall i \quad (5)$$
$$E_i = E_i^D + E_i^M \quad \forall i$$

where E_i^M indicates re-exports. This breakdown must be made in such a way that total domestic supply equals use of domestic production for each product:

$$\sum_j I^D_{i,j} + F_i^D + E_i^D = \sum_j S^D_{i,j} \quad \forall i \qquad (6)$$

and total imports equal total use of imported products

$$\sum_j I^M_{i,j} + F_i^M + E_i^M = M_i \quad \forall i \qquad (7)$$

So far we have only considered imports without any geographical breakdown. To study international production linkages however, the country of origin of imports is important as well. Let *k* denote the country from which imports are originating, then an additional breakdown of imports is needed such that

$$\sum_k \sum_j I^M_{i,j,k} + \sum_k F^M_{i,k} + \sum_k E^M_{i,k} = \sum_k M_{i,k} = M_i \quad \forall i \quad (8)$$

Bilateral international trade data in goods is collected from the UN COMTRADE database (which can be downloaded for example via the World Integrated Trade Solutions (WITS) webpage at http://wits.worldbank.org/witsweb/). This data base contains bilateral exports and imports by commodity and partner country at the 6-digit product level (Harmonised System, HS). Calculations used for the construction of the international USE tables are based on import values. Alternatively, we could have relied on export flow data. However, it is well-known that official bilateral import and export trade flows are not fully consistent due to reporting errors, etc. and hence this choice would make a difference. Following most other studies, we choose to use imports flows as these are generally seen as more reliable than export flows. Data at the 6-digit level often contains confidential flows which only appear in the higher aggregates. These confidential are allocated over the respective categories (see Stehrer, et al., 2010, for details).

Ideally one would like to have additional information based on firm surveys that inventory the origin of products used, but this type of information is hard to elicit and only rarely available. We use a non-survey imputation method that relies on a classification of detailed products in the ITS into three use categories. Our basic data is import flows of all countries covered in WIOD from all partners in the world at the HS6-digit product level taken from the UN COMTRADE database. Based on the detailed product description at the HS 6-digit level products are allocated to three use categories:

intermediates, final consumption and investment.[16] This resembles the well-known correspondence between the about 5,000 products listed in HS 6 and the Broad Economic Categories (BEC) as made available from the United Nations Statistics Division. These Broad Economic Categories can then be aggregated to the broader use categories mentioned above. For the WIOD this correspondence has been partly revised to better fit the purpose of linking the trade data to the SUTs (see Stehrer et al. 2010, for details).

For services trade no standardised database on bilateral flows exists. These have been collected from various sources (including OECD, Eurostat, IMF and WTO), checked for consistence and integrated into a bilateral service trade database. As services trade is taken from the balance of payments statistics it is originally reported at BoP codes. For building the shares a mapping to WIOD products has been applied. For these service categories there does not exist a breakdown into the use categories mentioned above; thus we either used available information from existing import use or symmetric import IO tables; for countries where no information was available we applied shares taken from other countries (see Stehrer et al., 2010, for details).

Based on our use-category classification we allocate imports across use categories in the following way. First, we used the share of use category l (intermediates, final consumption or investment) to split up total imports as provided in the supply tables for each product i. The resulting numbers for intermediates are allocated over using industries by proportionality assumption. Similarly, final consumption is allocated over the consumption categories (final consumption expenditure by households, final consumption expenditure by non-profit organisations and final consumption expenditure by government). Investment was allocated to column gross fixed capital formation. [17] This yields the import use table. Finally, each cell of the import use table is split up to the country of origin where country import shares might differ across use categories, but not within these categories. Note that here are discrepancies between the import values recorded in the National Accounts on the one hand, and in international trade statistics on the other. Some of them are due to conceptual differences, and others due to classification and data collection procedures (see extensive discussion in Guo, Web and Yamano 2009). As we rely on NAS as our benchmark we apply shares from the trade statistics to the NAS series. Thus, to be consistent with the imports as provided in the SUTs we use only shares derived from the ITS rather than the actual values.

Formally, let $m_{i,k}^{l}$ indicate the share of use categories l (intermediate, final consumption or investment) in imports of product i by a particular country from country k defined as

[16] A mixed category for products which are likely to have multiple uses was used as well; this category was allocated over the other use categories when splitting up the use tables.
[17] At a later stage we shall use information from existing imports SUTs or IOTs.

$$m_{i,k}^{l} = \frac{\tilde{M}_{i,k}^{l}}{\tilde{M}_{i}} \text{ such that } \sum_{k}\sum_{l} m_{i,k}^{l} = 1 \qquad (9)$$

where $\tilde{M}_{i,k}^{l}$ is the total value from all 6-digit products that are classified by use category l and WIOD product group i imported from country k, and $\tilde{M}_{i}$ the total value of WIOD product group i imported by a country. These shares are derived from the bilateral international trade statistics and applied to the total imports of product i as given in the SUT timeseries to derive imported use categories. $I_{i,j,k}^{M}$ is the amount of product group i imported from country k and used as intermediate by industry j. It is given by:

$$I_{i,j,k}^{M} = m_{i,k}^{I} M_{i} \frac{I_{i,j}}{I_{i}} \quad \forall j \qquad (10)$$

where $I_{i} = \sum_{j} I_{i,j} \quad \forall i$ such that $\frac{I_{i,j}}{I_{i}}$ is the share of intermediates of product i used by industry j. Similarly, let f denote the final use categories (final consumption by households, by non-profit organisations and by government). Then the amount of product group i imported from country k and used as final use category f, $FC_{i,f,k}^{M}$, is given by:

$$FC_{i,f,k}^{M} = m_{i,k}^{FC} M_{i} \frac{FC_{i,f}}{FC_{i}} \qquad (11)$$

The amount of product group i imported from country k and used as investment, $GFCF_{i,k}^{M}$, is given by:

$$GFCF_{i,k}^{M} = m_{i,k}^{GFCF} M_{i} \qquad (12)$$

Finally, we derive the use of domestically produced products as the residual by subtracting the imports from total use as follows:

$$\begin{aligned} I_{i,j}^{D} &= I_{i,j} - \sum_{k} I_{i,j,k}^{M} \quad \forall i, j \\ FC_{i,f}^{D} &= FC_{i,f} - \sum_{k} FC_{i,f,k}^{M} \quad \forall i \qquad (13) \\ GFCF_{i}^{D} &= GFCF_{i} - \sum_{k} GFCF_{i,k}^{M} \quad \forall i \end{aligned}$$

Note that our approach differs from the standard proportionality method popular in the literature and applied e.g. by GTAP. In those cases, a common import proportion is used for all cells in a use row, irrespective the user. This common proportion is simply calculated as the share of imports in total supply of a product. We find that import proportions differ widely across use categories and importantly, within each use category they differ also by country of origin. Our detailed bilateral approach ensures that this type of information is reflected in the international SUTs and consequently the WIOT.

As a final step, international SUTs are transformed into a world input-output table. IO tables are symmetric and can be of the product-by-product type, describing the

amount of products needed to produce a particular good or service, or of the industry-by-industry type, describing the flow of goods and services from one industry to another. In case each product is only produced by one industry, the two types of tables will be the same. But the larger the share of secondary production, the larger the difference will be. The choice for between the two depends on the type of research questions. Many foreseen applications of the WIOT, such as those described in the next sections, will rely heavily on industry-type tables as the additional data, such as employment or investment, is often only available on an industry basis. Moreover, the industry-type table retains best the links with national account statistics.

An IOT is a construct on the basis of a SUT at basic prices based on additional assumptions concerning technology. We use the so-called "fixed product-sales structure" assumption stating that each product has its own specific sales structure irrespective of the industry where it is produced. Sales structure here refers to the proportions of the output of the product in which it is sold to the respective intermediate and final users. This assumption is most widely used, not only because it is more realistic than its alternatives, but also because it requires a relative simple mechanical procedure. Furthermore, it does not generate any negatives in the IOT that would require manual rebalancing. Application of manual ad-hoc procedures would greatly reduce the tractability of our methods. Chapter 11 in the Eurostat handbook (Eurostat, 2008) provides a useful and extensive discussion of the transformation of SUTs into IOTs, including a mathematical treatment.

The full WIOT will contain data for forty countries covered in the WIOD. Including the biggest countries in the world, this set covers more than 85 per cent of world GDP. Nevertheless to complete the WIOT and make it suitable for various modelling purposes, we also added a region called the Rest of the World (RoW) that proxies for all other countries in the world. The RoW needs to be modelled due to a lack of detailed data on input-output structures. Imports from RoW are given as as share of imports from RoW from trade data applied to the imports in the supply table. Hence, exports from the RoW are simply the imports by our set of countries not originating from the set of WIOD countries. Exports to RoW from the set of WIOD countries or, equivalently, imports by the ROW are defined residually to ensure that exports from all countries (incl. RoW) equal the imports by all countries (incl. RoW). Production and consumption in the ROW will be modelled based on totals for industry output and final use categories from the UN National Accounts, assuming an input-output structure equal to that of an average developing country. Also, at a later stage we will add in a separate oil-producing region that will be useful in particular in environmental applications.

For an elaborate discussion of construction methods, practical implementation and detailed sources of the WIOT, see Erumban et al. (2011).

Table 1 Foreign value added shares in manufacturing final output in regions (in %)

	China		EU		East Asia		NAFTA		Other	
	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006
China	85.8	79.0	0.3	1.4	0.6	2.9	0.3	1.8	0.3	1.7
EU	2.0	3.6	89.2	83.2	1.8	2.6	3.9	3.8	5.7	6.8
East Asia	6.5	7.2	1.5	1.6	91.5	82.7	2.5	2.0	2.6	1.8
NAFTA	2.4	2.5	4.0	3.8	3.3	3.2	90.7	86.6	2.3	2.4
Other	3.4	7.7	5.0	10.0	2.8	8.6	2.6	5.9	89.0	87.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: Contributions of value added from regions (in rows) to manufacturing final output in regions (columns).

Source: Calculations based on World Input-Output Database, preliminary version February 2011.

Table 2 Domestic and foreign value added shares in manufacturing final output in countries (in %)

	Domestic		China		East Asia		EU		NAFTA		Other		Total (mil US$)	
	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006
European Union														
EST	56.8	36.3	0.4	4.1	1.6	4.3	26.9	30.2	3.7	3.7	10.6	21.4	1,057	3,017
SVK	65.8	43.6	0.2	2.1	0.9	3.8	22.7	31.8	1.3	2.3	9.1	16.4	5,770	19,277
BEL	52.1	44.0	0.5	1.9	2.4	2.5	34.0	34.3	7.2	5.7	3.8	11.5	71,978	110,051
LUX	54.9	45.3	0.2	1.0	1.1	1.8	37.4	41.0	3.4	3.5	3.0	7.4	2,248	6,073
MLT	48.1	48.2	0.7	2.0	2.2	2.5	37.3	32.6	4.1	4.4	7.6	10.4	756	1,155
HUN	67.4	48.6	0.2	3.4	1.0	4.7	21.4	29.2	1.4	3.7	8.7	10.5	15,662	36,472
IRL	61.5	48.7	0.5	2.5	2.7	2.5	22.0	13.1	9.5	27.2	3.9	6.1	26,916	72,485
LTU	62.1	49.3	0.1	1.2	0.6	1.1	14.9	18.4	1.5	1.4	20.8	28.6	1,644	6,799
CZE	65.6	51.2	0.2	2.6	0.9	3.6	24.2	28.7	1.6	2.7	7.4	11.2	15,856	45,848
NLD	61.3	53.5	0.5	1.9	2.1	2.8	17.8	20.9	11.3	6.6	7.0	14.3	96,820	152,719
CYP	65.9	53.7	0.7	1.0	2.5	0.9	20.4	11.6	3.2	1.6	7.3	31.2	795	2,468
SVN	64.8	54.0	0.3	1.1	1.2	1.6	25.2	31.9	2.3	2.1	6.3	9.4	5,503	8,189
BGR	68.5	54.6	0.2	1.7	0.5	1.3	13.8	27.8	1.2	2.6	15.8	12.0	4,153	8,809
AUT	72.3	59.3	0.2	1.1	1.1	1.3	16.9	25.5	2.0	2.7	7.6	10.0	51,237	69,937
LVA	57.0	59.5	0.1	1.1	0.7	0.9	24.1	22.2	1.5	1.6	16.5	14.8	878	3,331
PRT	68.2	61.5	0.2	0.9	1.6	1.0	18.5	23.2	4.8	2.2	6.7	11.3	30,916	40,111
SWE	70.4	62.1	0.2	1.5	1.4	3.0	20.1	20.1	2.5	3.9	5.4	9.3	52,440	84,850
FIN	73.7	63.6	0.3	2.1	2.5	3.2	12.0	14.4	6.3	3.2	5.3	13.5	23,779	39,645
DNK	73.8	65.2	0.3	1.3	1.0	1.7	17.2	19.8	1.8	3.2	5.8	8.7	35,732	49,021
ESP	77.3	66.0	0.2	1.2	1.1	1.1	13.1	17.3	2.8	2.6	5.4	11.8	143,673	227,359
ROM	73.0	66.1	0.3	1.2	0.7	1.1	15.6	17.0	1.5	1.9	8.9	12.7	11,286	33,156
POL	82.1	66.4	0.2	1.4	0.6	2.1	11.6	18.4	1.1	2.1	4.5	9.7	34,594	86,951
FRA	78.2	69.0	0.2	1.1	1.4	1.3	11.6	16.7	4.3	3.2	4.3	8.8	325,086	440,046
GRC	78.0	70.8	0.2	0.8	0.9	1.3	12.5	11.6	2.2	1.4	6.3	14.1	25,325	37,150
DEU	81.1	71.2	0.3	1.4	1.7	1.6	9.8	14.5	3.1	3.0	4.1	8.4	631,705	752,086
ITA	78.9	72.0	0.3	1.2	1.0	0.9	10.9	11.4	3.7	2.6	5.3	11.9	308,074	453,630
GBR	77.1	73.0	0.4	1.3	2.0	1.4	11.2	12.8	4.5	3.4	4.9	8.0	249,623	346,501

Table 2 Domestic and foreign value added shares in manufacturing final output in countries (in %) (continued)

	Domestic		China		East Asia		EU		NAFTA		Other		Total (mil US$)	
	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006
NAFTA														
CAN	66.3	67.0	0.5	1.7	2.9	2.4	5.6	3.9	21.9	20.8	2.7	4.2	128,830	223,711
USA	88.2	80.9	0.3	1.7	2.5	1.9	3.8	3.9	2.5	5.1	2.7	6.5	1,352,719	1,869,388
MEX	75.7	73.3	0.2	2.3	1.9	2.3	3.0	3.1	17.8	15.6	1.5	3.4	123,312	323,184
East Asia														
TWN	66.3	53.6	1.2	6.6	12.4	13.9	6.3	5.4	9.1	7.4	4.7	13.1	87,417	95,430
KOR	76.3	69.0	1.4	4.1	5.4	5.5	4.3	4.4	5.8	4.2	6.8	12.8	125,082	196,175
JPN	93.1	84.9	0.5	2.3	0.5	1.1	1.2	1.9	2.5	2.6	2.2	7.2	1,120,226	927,429
CHN	85.8	79.0	0.0	0.0	6.5	7.2	2.0	3.6	2.4	2.5	3.4	7.7	329,584	1,104,709
Other														
TUR	81.3	74.3	0.5	1.4	1.2	1.2	8.7	9.3	2.0	1.8	6.4	11.9	65,130	153,313
IND	89.4	81.9	0.4	2.1	1.0	1.1	3.5	3.6	1.1	1.9	4.6	9.4	123,698	265,835
IDN	83.0	82.6	0.7	1.9	6.1	2.9	4.4	3.8	2.4	1.9	3.4	6.9	71,790	110,555
AUS	84.8	83.1	0.5	1.5	2.8	1.8	4.8	3.5	3.1	2.8	4.0	7.3	57,419	95,247
BRA	90.7	86.7	0.2	0.8	1.0	1.1	2.8	3.7	2.1	2.6	3.2	5.1	173,618	243,959
RUS	89.0	87.8	0.2	0.8	0.7	2.1	5.3	5.5	0.8	0.9	4.0	2.9	56,983	147,215

Note: Contributions of value added from domestic and foreign (in columns) to manufacturing final output in countries (rows).

Source: Calculations based on World Input-Output Database, preliminary version February 2011.

Table 3 Value added contribution of regions to global manufacturing final output

	in mil 1995 US$		in percentage of world	
	1995	2006	1995	2006
China	304,515	825,717	4.9	11.2
East Asia	1,336,115	956,308	21.6	13.0
NAFTA	1,614,457	1,829,663	26.1	24.9
EU	2,082,841	2,270,211	33.7	30.9
BRIIAT	556,578	886,561	9.0	12.1
Other	292,243	578,858	4.7	7.9
World	6,186,750	7,347,318	100.0	100.0

Source: Using exchange rates for currency conversion and US CPI for deflation to 1995$. Calculations based on World Input-Output Database, preliminary version May 2011.

Table 4 Value added contribution of production factors in regions to global manufacturing final output

	Value added by high-skills		Value added by medium-skills		Value added by low-skills		Value added by capital	
	1995	2006	1995	2006	1995	2006	1995	2006
in mil 1995 US$								
China	12,812	36,209	84,576	211,649	65,497	153,334	127,324	354,166
East Asia	201,600	191,272	447,064	290,833	139,442	43,344	506,476	393,650
NAFTA	330,437	394,288	526,717	470,795	94,701	87,734	593,682	778,169
EU	180,593	269,390	916,627	945,812	296,506	245,127	622,649	722,032
BRIIAT	33,811	64,871	43,454	66,080	186,100	221,809	278,365	469,947
Other	14,189	42,704	13,869	29,073	64,120	119,767	178,966	332,683
World	773,441	998,735	2,032,308	2,014,243	846,365	871,115	2,307,462	3,050,646
in percentages of world value added								
China	0.2	0.5	1.4	2.9	1.1	2.1	2.1	4.8
East Asia	3.3	2.6	7.2	4.0	2.3	0.6	8.2	5.4
NAFTA	5.3	5.4	8.5	6.4	1.5	1.2	9.6	10.6
EU	2.9	3.7	14.8	12.9	4.8	3.3	10.1	9.8
BRIIAT	0.5	0.9	0.7	0.9	3.0	3.0	4.5	6.4
Other	0.2	0.6	0.2	0.4	1.0	1.6	2.9	4.5
World	12.5	13.6	32.8	27.4	13.7	11.9	37.3	41.5

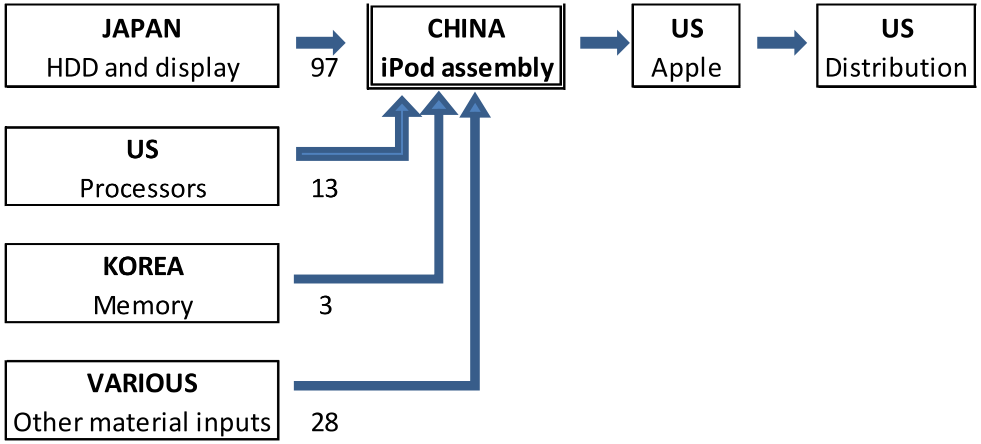
Source: Using exchange rates for currency conversion and US CPI for deflation to 1995$. Calculations based on World Input-Output Database, preliminary version May 2011.

Table 5 Value added contribution of sectors in regions to global manufacturing final output

	Value added from resource industries		Value added from manufacturing industries		Value added from services industries	
	1995	2006	1995	2006	1995	2006
in mil 1995 US$						
China	64,898	144,678	178,160	494,516	61,457	186,523
East Asia	90,528	55,495	833,667	577,457	411,920	323,356
NAFTA	128,325	220,635	930,133	946,529	555,999	662,499
EU	148,533	133,376	1,181,844	1,199,834	752,465	937,001
BRIIAT	104,974	227,785	280,443	372,682	171,161	286,094
Other	87,380	214,326	117,143	206,591	87,720	157,941
World	624,639	996,295	3,521,389	3,797,609	2,040,722	2,553,413
in percentages of world value added						
China	1.0	2.0	2.9	6.7	1.0	2.5
East Asia	1.5	0.8	13.5	7.9	6.7	4.4
NAFTA	2.1	3.0	15.0	12.9	9.0	9.0
EU	2.4	1.8	19.1	16.3	12.2	12.8
BRIIAT	1.7	3.1	4.5	5.1	2.8	3.9
Other	1.4	2.9	1.9	2.8	1.4	2.1
World	10.1	13.6	56.9	51.7	33.0	34.8

Source: Using exchange rates for currency conversion and US CPI for deflation to 1995$. Calculations based on World Input-Output Database, preliminary version May 2011. Resource industries include agriculture, mining, wood manufacturing, non-metallic minerals manufacturing and oil refining. Manufacturing includes other manufacturing industries. Services include all other industries.

Figure 1 Global value chain of the iPod.



Value added (in $)		34*		4		79		75	
Price (in $)	107*		141		145		224		299

Source: stylised representation based on information in Linden et al. (2009) and Dedrick et all (2010).

Note: * Gross profit margins for suppliers of the 10 most important inputs. The remainder of 107 is cost of goods including materials, components and direct labour.

Figure 2 Exogenous and endogenous flows

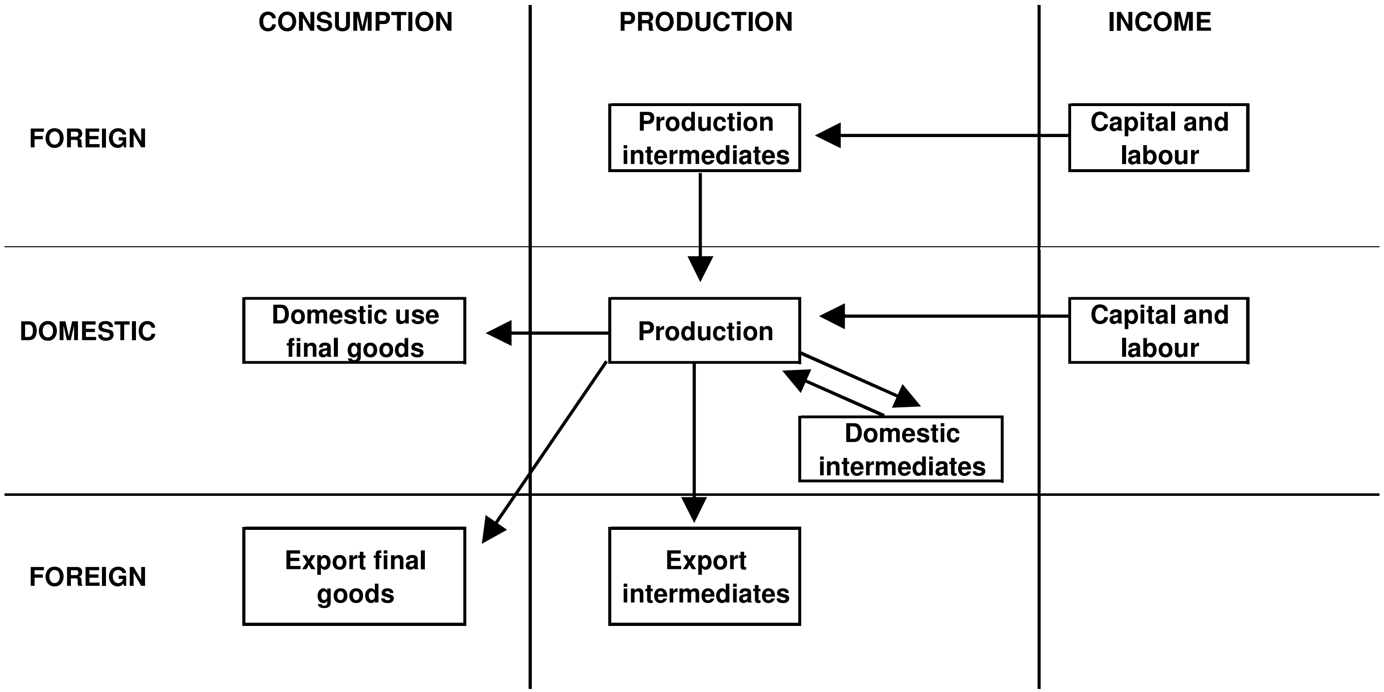
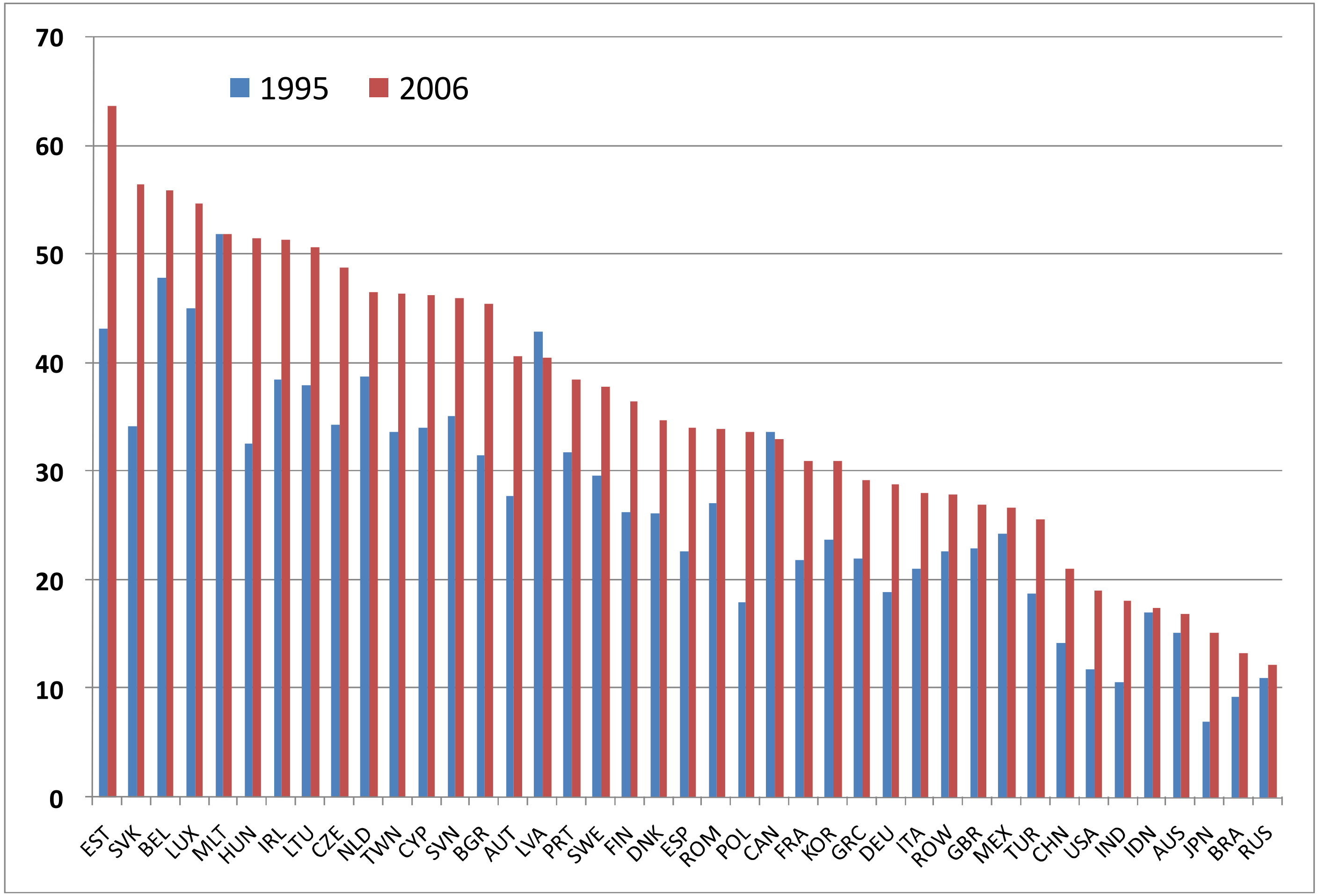


Figure 3 Schematic outline of World Input-Output Table (WIOT), three regions

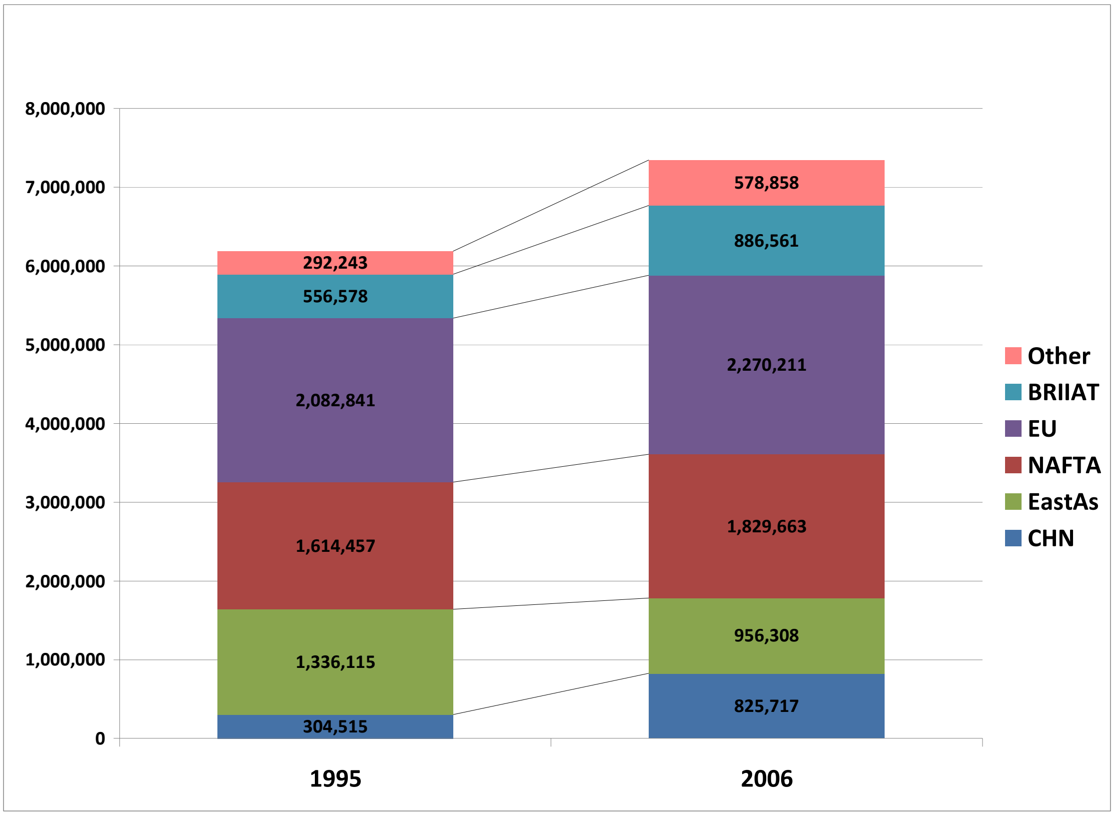
		Country A Intermediate *Industry*	Country B Intermediate *Industry*	Rest of World Intermediate *Industry*	Country A Final domestic	Country B Final domestic	Rest of Final domestic	Total
Country A	*Industry*	Intermediate use of domestic output	Intermediate use by B of exports from A	Intermediate use by RoW of exports from A	Final use of domestic output	Final use by B of exports from A	Final use by RoW of exports from A	Output in A
Country B	*Industry*	Intermediate use by A of exports from B	Intermediate use of domestic output	Intermediate use by RoW of exports from B	Final use by A of exports from B	Final use of domestic output	Final use by RoW of exports from B	Output in B
Rest of World (RoW)	*Industry*	Intermediate use by A of exports from RoW	Intermediate use by B of exports from RoW	Intermediate use of domestic output	Final use by A of exports from RoW	Final use by B of exports from RoW	Final use of domestic output	Output in RoW
		Value added	Value added	Value added				
		Output in A	Output in B	Output in RoW				

Figure 4 Share of foreign value added in domestic final manufacturing output (in %), 1995 and 2006



Source: see Table 3

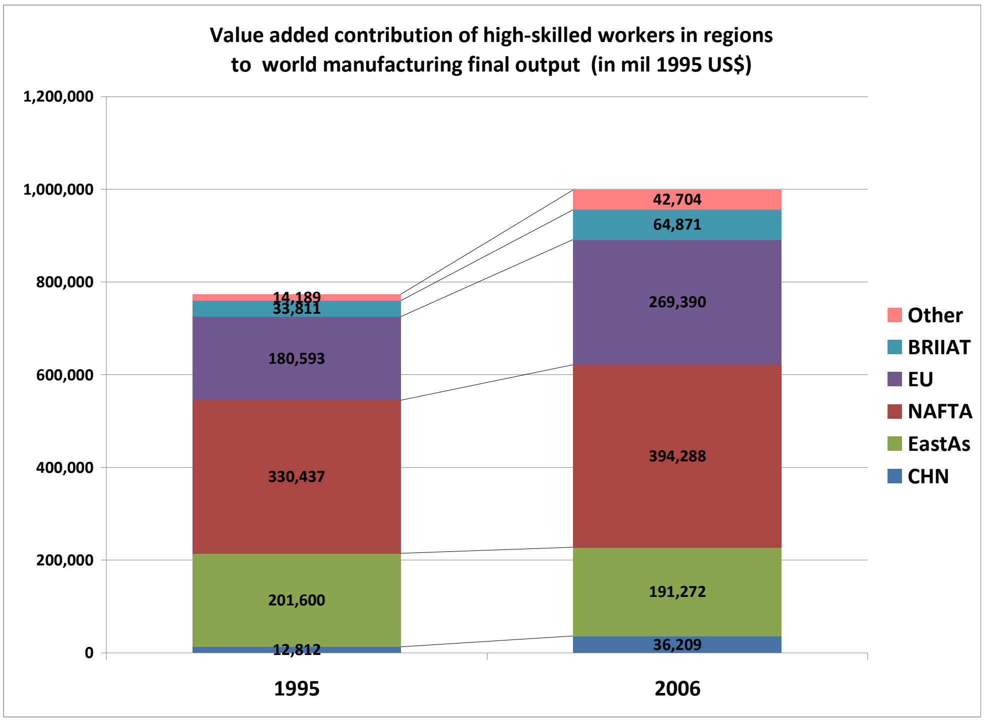
FIGURE 5 Value added contribution of regions to world manufacturing final output (in 1995 US$)



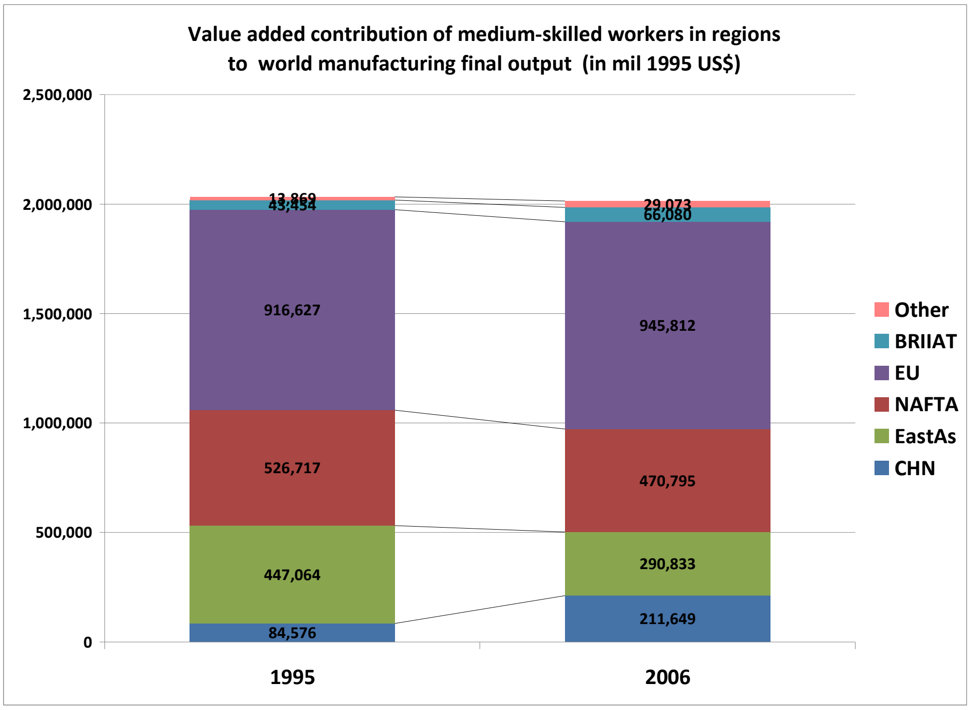
Source: see Table 3.

FIGURE 6 Value added contribution of production factors in regions to global manufacturing final output (in 1995 US$)

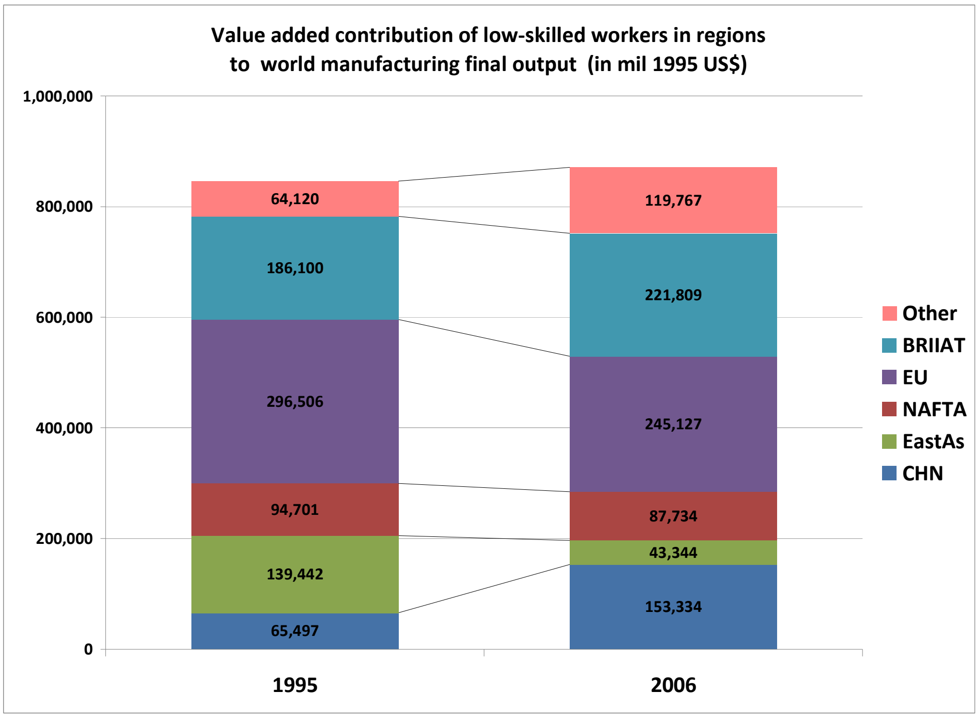
(a) High-skilled workers



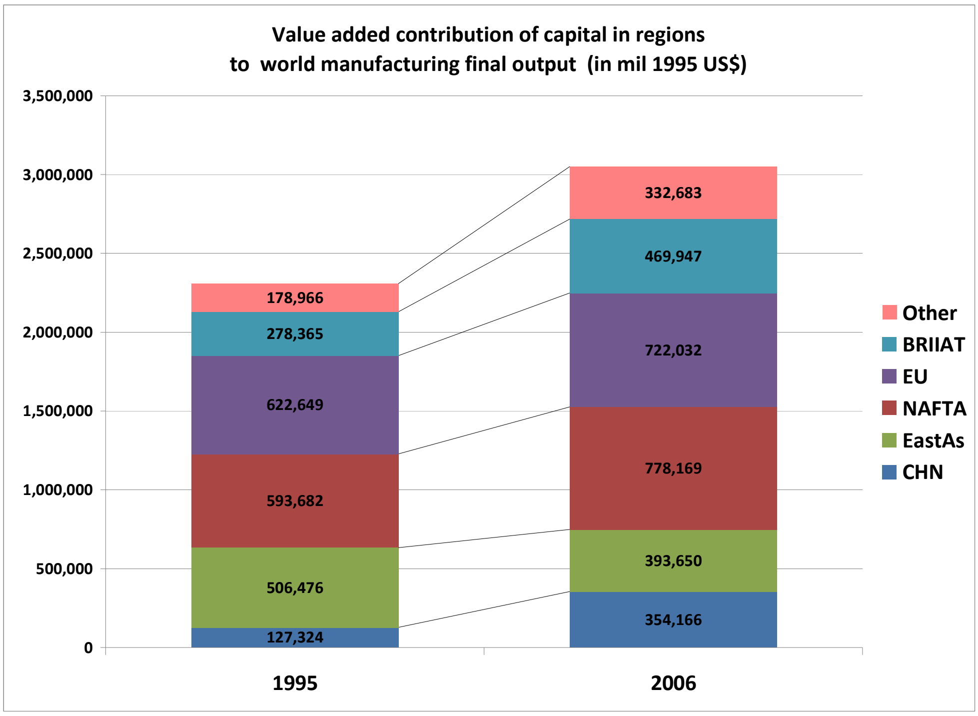
(b) Medium-skilled workers



(c) Low-skilled workers



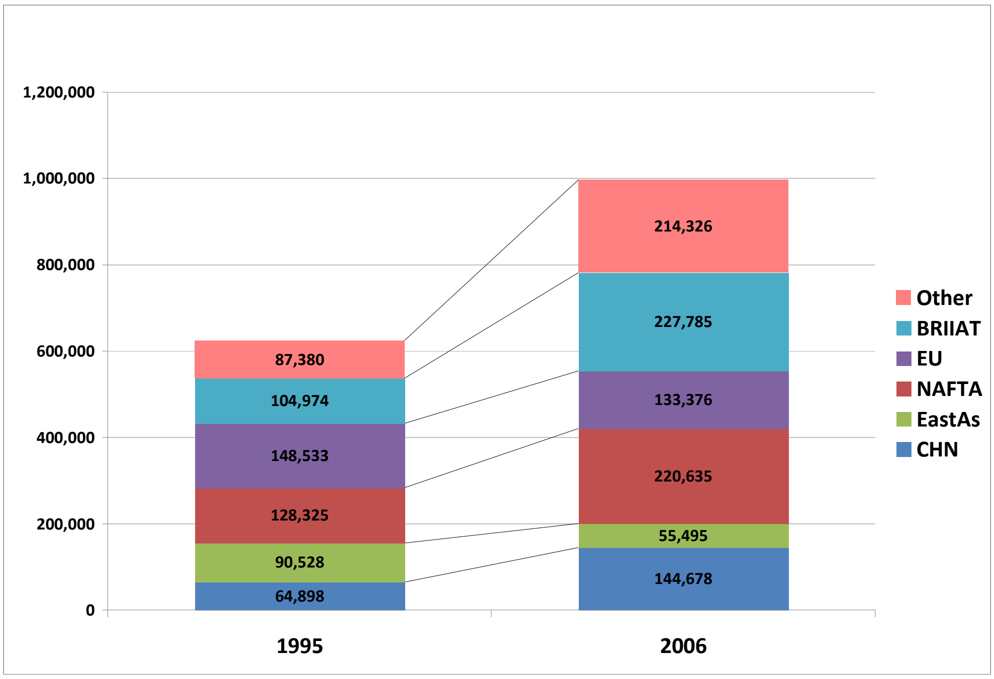
(d) Capital



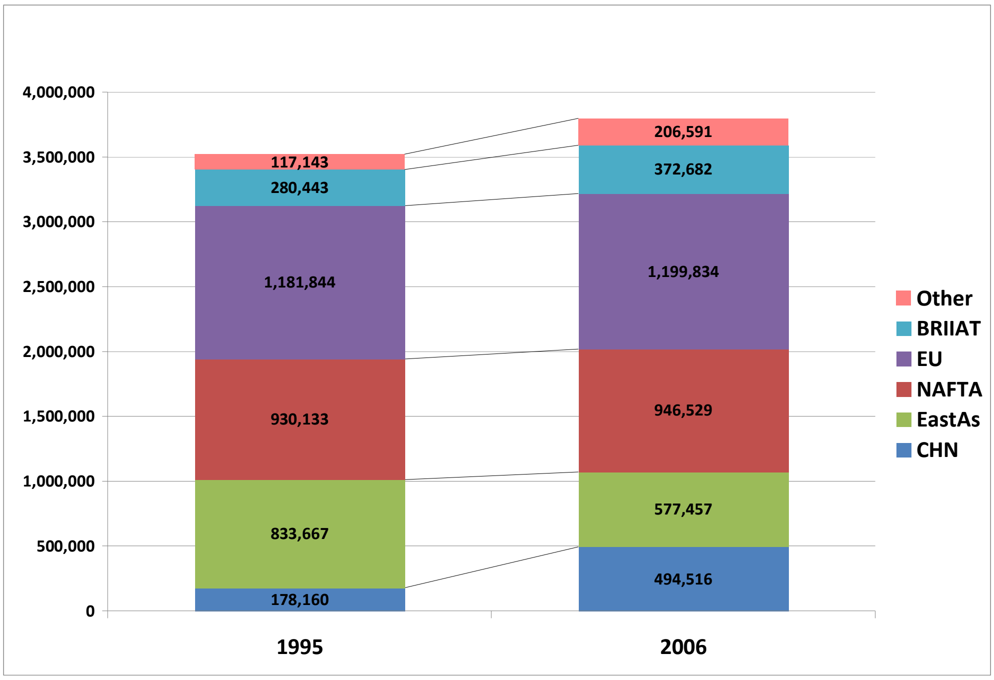
Source: see Table 4.

FIGURE 7 Value added contribution of sectors in regions to global manufacturing final output

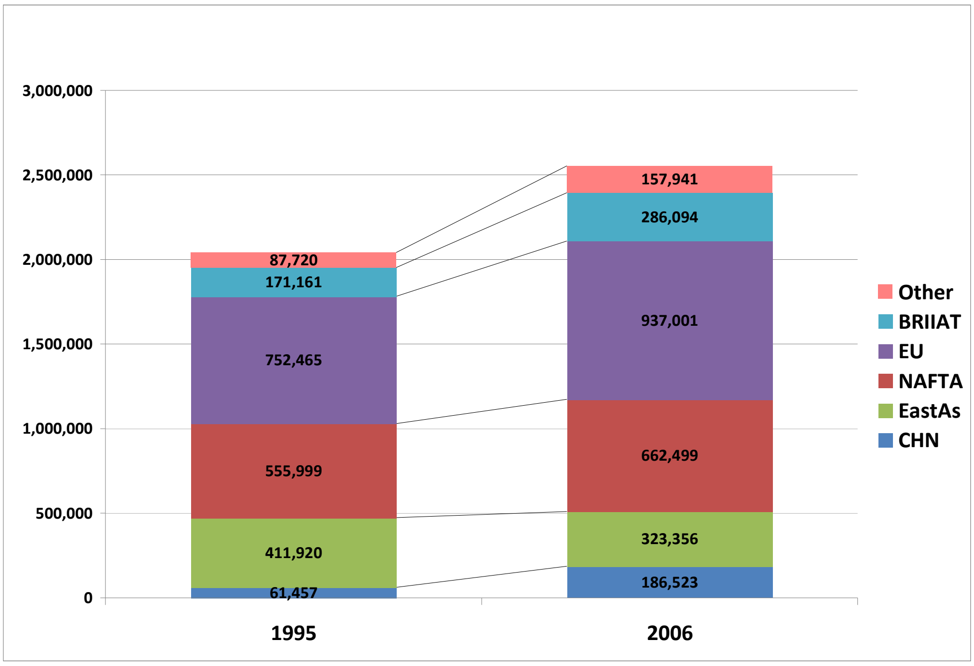
(A) Resource industries



(B) Manufacturing industries



(C) Services industries



Source: see Table 5.

Appendix Table National supply-use and input-output tables used for construction of WIOD

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Australia		SUT (106c * 106i)							SUT (233c * 53i)	SUT (233c * 53i)			
Austria	SUT (59c * 59i)		SUT (59c * 59i)		SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)		
Belgium	SUT (59c * 59i)		SUT (59c * 59i)		SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)			
Brazil						SUT (110c * 55i)	SUT (110c * 55i)	SUT (110c * 55i)	SUT (110c * 55i)	SUT (110c * 55i)	SUT (110c * 55i)	SUT (110c * 55i)	
Bulgaria						SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)			
Canada			SUT (BP) (473c*122i)	SUT (BP) (473c*122i)	SUT (BP) (473c*122i)	SUT (BP) (473c*122i)	SUT (BP) (473c*122i)	SUT (BP) (473c*122i)	SUT (BP) (473c*122i)	SUT (BP) (473c*122i)	SUT (BP) (473c*122i)	SUT (BP) (473c*122i)	
China			SUT(PR) (40c * 40i) & IO(PR) (124c * 124c)					SUT(PR) (42c * 42i) & IO(PR) (122c * 122c)					SUT(PR) (42c * 42i) & IO(PR) (135c * 135c)
Cyprus*						SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	
Czech Republic	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)		
Denmark		SUT (59c * 59i)			SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)		
Estonia			SUT (59c * 59i)		SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	
Finland	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	
France	SUT (59c * 59i)		SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	
Germany	SUT (59c * 59i)		SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	
Greece						SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	
Hungary				SUT (59c * 59i)	SUT (59c * 59i)			SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	
India				SUT(FC) (115c * 115i)					SUT(FC) (130c * 130i)			SUT(FC) (130c * 130i)	
Indonesia	IO (172c * 172c)					IO (175c * 175c)					IO (175c * 175c)		

Appendix Table (continued) National supply-use and input-output tables used for constructing of WIOD

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Ireland						SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)			SUT (59c * 59i)		
Italy	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)		
Japan	IO(PR) (108i * 108i)					IO(PR) (108i * 108i)							
Korea	IO(PR) (402c*402i)					IO(PR) (404c*404i)					IO(PR) (403c*403i)		
Latvia													
Lithuania		SUT (59c * 59i)		SUT (59c * 59i)					SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)		
Luxembourg	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	
Malta						SUT (59c * 59i)	SUT (59c * 59i)						
Mexico									SUT (79c * 79i)				
Netherlands	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	
Poland		SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)						SUT (59c * 59i)		
Portugal	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	
Romania						SUT (59c * 59i)			SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	
Russia	SUT (110c *59i)												
Slovak Republic	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	
Slovenia						SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	
Spain	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	
Sweden	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	
Taiwan		IO (596c*160i)					IO (610c*160i)					IO (554c*165i)	
Turkey		SUT(PR) (97c*97i)		SUT (97c*97i)				SUT (59c*59i)					
United Kingdom	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)	SUT (59c * 59i)				
USA	SUT(PR) (130c * 130i)	SUT(PR) (66c * 65i)	SUT(PR) (66c * 65i)	SUT(PR) (66c * 65i)	SUT(PR) (66c * 65i)	SUT(PR) (66c * 65i)	SUT(PR) (66c * 65i)	SUT(PR) (66c * 65i)	SUT(PR) (66c * 65i)	SUT(PR) (66c * 65i)	SUT(PR) (66c * 65i)		

Note: All tables are at purchasers' prices unless otherwise indicated (PR stands for producer prices, FC for factor cost and BP for basic price), i stands for industry dimension and c for commodity. * Cyprus SUTs based on Greece.