Trade in value added and factors: A comprehensive approach

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Abstract

Based on recent approaches to measuring the factor content of trade when intermediates are traded we decompose value added trade and its components (capital and labor, as well as their subcomponents ICT and Non-ICT capital and educational attainment categories) distinguishing between various categories of foreign value added content of exports and imports. We add to the literature by simultaneously considering both exports and imports allowing for a focus on the patterns and dynamics of net value added trade and its components rather than vertical specialization patterns based on exports only. We show that a country's trade balance in value added equals its trade balance in gross trade. Empirically we present results of an application of the proposed decomposition method based on the recently compiled World Input-Output Database (WIOD) covering 40 countries and 35 industries over the period 1995-2006. We show that the domestic value added content of exports and the foreign value added content of bilateral trade dominates, but that the foreign or multilateral part is increasing over time pointing towards increasing international integration of production. We add a discussion of the trade balances with respect to production factors in value terms providing a distinct view on the patterns of trade deficits and surpluses across countries.

Keywords: value added trade; trade in factors; trade integration; vertical specialization; production networks

JEL-classification: F1; F15; F19;

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TRADE IN VALUE ADDED AND FACTORS: A COMPREHENSIVE APPROACH[1]

1 Introduction

Trade in value added has become an increasingly debated topic due to the rapid integration of production processes and the further inclusion of countries in this process. Though this process has been ongoing for quite some time there have been rapid integration processes in the world economy taking place over the last decade or so. In the 1990s this was the creation of the North American Free Trade Agreement (NAFTA) concerning the US, Canada and Mexico and the integration of formerly communist countries with Western EU countries which started after the transformational recession in these countries and led to the accession of some countries into the European Union in 2004. Further, large developing countries such as Brazil, Russia, India and China (and Indonesia and South Africa to a lesser extent) - termed the BRIC, BRIIC, or BRICS countries - became important players on world markets at least in particular industries. This implied an increase in overall trade flows in the world economy with increasing shares of imports and exports between these newly integrating countries and the developed world. This integration of trade flows in the world economy was further accompanied by increasing foreign direct investment activities. One particular feature of this integration process was also the integration of production structures in the sense that firms offshore activities to other countries to exploit cost advantages in particular stages of production. This integration of production processes has been theoretically analyzed under different headings including 'fragmentation', 'slicing up the value chain', 'outsourcing' and 'offshoring' or the 'second unbundling' and recent contributions emphasizing 'trade in tasks'.

From an empirical point of view there is still the challenge to properly measure this ongoing integration of production processes. The literature ranges from particular case studies for products like the Barbie doll (Tempest, 1996), the iPod (Linden et al., 2009; Varian, 2007), computers (Kraemer and Dedrick, 2002), or the Nokia N95 (Ali-Yrkkoö, 2010) or more complex products like cars (Baldwin, 2009) or airplanes (Grossman and Rossi-Hansberg, 2008), to studies of trade patterns in particular products such as 'parts and components' and overall trade in intermediates versus trade in final goods (Miroudot et al., 2009; Stehrer et al., 2011) and a number of studies focusing on the magnitude and changes of 'vertical

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specialization' patterns. In the European context the changes in the international structure of production are discussed from a multi-disciplinary point of view in Faust et al. (2004). This book also provides a number of case studies at the level of industries (the automobile industry, the electronics industry, and the apparel industry). Other recent studies focus on measuring trade in value added between countries thus trying to measure how much of value added created in the production process in one country is exported thus 'netting out' the value already embodied in imported products and the extent of 'vertical specialization' or 'vertical integration' (Hummels et al., 2001; Daudin et al., 2009; Johnson and Noguera, 2009; Koopman et al., 2010), with an overview of these approaches provided by Meng and Yamano (2010); see also Meng et al. (2011) for a decomposition of vertical specialization measures. Related to these are papers on the measurement of trade in value added, examples including Escaith (2008); Maurer and Degain (2010); Timmer et al. (2011). Further there are a number of papers with a focus on the Asian production and trade network (recent examples include Meng and Inomata, 2009; Hiratsuka and Uchida, 2010; Yamano et al., 2010).

In the international trade literature this issue has to some extent been addressed over a number of years with work measuring the factor content of trade flows. The seminal contribution in this respect was that of Vanek (Vanek, 1968) and the so called Heckscher-Ohlin-Vanek model; for a recent overview see (Baldwin, 2008). In this model the perspective switches from that on trade in goods to trade in factors of production embodied in the goods traded. Empirically, this goes back even earlier to the important contribution of Leontief (Leontief, 1953) which triggered a number of subsequent studies focusing on the 'Leontief paradox'. Only recently have there been successful attempts to solve this 'paradox' by allowing for (Hicks neutral) technology differences across countries (Trefler, 1993). One particular concern in these contributions was to properly account for trade in intermediate products, an issue which has been the focus of some recent contributions including those of Davis and Weinstein (2001), Reimer (2006), and Trefler and Zhu (2010), though this issue was considered earlier by Deardorff (1982) and Staiger (1986).

The starting point of this paper are these recent papers accounting for intermediates trade and in particular the contribution of Trefler and Zhu (2010) where a Vanek-consistent measure of the factor content of trade is proposed. Based on this approach we introduce an alternative approach to decompose trade flows in value added and its components such as ICT and Non-ICT capital and labor differentiated by skills and relate these to recent approaches of measuring vertical specialization patterns (Hummels et al., 2001; Daudin et al., 2009; Johnson and Noguera, 2009; Koopman et al., 2010). Our approach can

be aligned with the measures of vertical specialization proposed in these studies which will be discussed below. We add to this literature by simultaneously looking at both exports and imports of value added thus focussing on net trade in value added rather than exports or imports of value added separately. The proposed framework also allows to show that a country's net export in value added equals its net exports in gross trade which aligns this approach to national accounting. We differentiate between domestic and foreign components in value added exports and imports. The data allow us to further break down the figures of (net) trade in value added in to the components of value added. Particularly, we split value added (in value terms) into capital and labor income, and these two into ICT and Non-ICT capital and high, medium and low educated (by ISCED categories) labor income, respectively. The paper thus tries to link the literature on trade in value added and vertical specialization and on the factor content of trade by applying a decomposition approach.[2]

The paper proceeds as follows. In Section 2 we introduce our method of decomposing trade in value added. Section 3 provides a short overview of the recently compiled world input output database (WIOD) database that we use. Based on this we present selected results in Section 4. Section 5 concludes and points towards further avenues of research.

2 Measuring trade in value added and factors

In this section we introduce our approach to the decomposition of trade flows in value added exports and imports and consequently net trade. The same approach is also used to further to split up these flows into value added components, i.e. the value of labor and capital traded which can be further split up by various categories as outlined below. There is already a wide literature on the measurement of vertical specialization, value added chains and trade in value added (see e.g. Hummels et al., 2001; Johnson and Noguera, 2009; Daudin et al., 2009; Koopman et al., 2010; Timmer et al., 2011).

Often this literature focuses on measuring the vertical integration of production processes focusing on exports and thus leaving out the aspect that all countries are also important importers of intermediates and the existence of two-way trade in intermediates as outlined above.[3] On the other hand, the literature focusing on the effects of outsourcing on labor markets (employment and wages) and other variables like productivity often focus on the import side only. In this paper we therefore aim at including both

[2] In future research this decomposition can be continued further as will be outlined in the conclusions.

[3] The literature focuses on the 'import content of *exports*'; using supply-driven IO models allows one to also calculate the 'export content of imports' (see for example Meng and Yamano, 2010).

sides of trade to measure the extent of exports, imports and net trade in value added and its relative importance across countries' trading patterns. The WIOD database (see below) further allows us to follow the respective trends over time and to further decompose value added flows into its components.

Another strand of literature which is related to the issue of trade in value added and vertical specialization focuses on trade in factors and is often motivated by the Heckscher-Ohlin-Vanek theorem with the further complication when trade in intermediates has to be accounted for (see Deardorff (1982) and Staiger (1986) for early contributions and Reimer (2006) and Trefler and Zhu (2010) for more recent ones). The approach suggested here is motivated by a recent paper on trade in factors, Trefler and Zhu (2010), which focuses on the correct (or 'Vanek consistent' way) of calculating the factor content of trade with trade in intermediates. We apply a similar method of calculating the factor content with two modifications. First, we apply this approach using value added shares in gross output and capital and labor income shares in gross output rather than physical input coefficients which most of the papers focusing on trade in factors is based. In essence, we therefore not only allow for cross-country and cross-industry differences in direct and indirect input coefficients but also for differences in factor rewards.[4] Second, we decompose the resulting measure into several categories which are outlined below in detail. In particular, this latter aspect links this paper to other approaches of measuring vertical integration and trade in value added.

2.1 A comprehensive approach

The starting point for the analysis are indicators of the share of value added in gross output denoted by vector $\mathbf{v}$, the Leontief inverse of the global input-output matrix, $\mathbf{L} = (\mathbf{I} - \mathbf{A})^{-1}$ with $\mathbf{A}$ denoting the coefficients matrix, and the flows of exports and imports of goods between countries denoted by $\mathbf{t}$. For simplicity we first discuss our approach for the case of three countries without an industry dimension. Further, we discuss net trade in value added from the viewpoint of country 1 without any loss in generality. In this special case the vector of value added coefficients becomes $\mathbf{v}' = (v^1, v^2, v^3)$, the Leontief-inverse is of dimension 3×3 and the trade vector is written as $\mathbf{t} = (x^{1*}, -x^{21}, -x^{31})$ where $x^{1*} = \sum_{p,p\neq 1} x^{1p}$ denotes exports of country 1 to all countries and x^{r1} denotes exports of country r to 1, i.e. imports of country 1. These imports are included in negative terms which results in net trade of value added for country 1, i.e. $t_V = \mathbf{v}'\mathbf{L}\mathbf{t}$. For the decomposition procedure however we need the individual entries of the matrix capturing exports and imports of country 1 which is achieved by a diagonalization

[4] This can later be decomposed into the effects of changes in productivity, factor rewards and trade patterns by splitting ratios over gross output into factor rewards and physical input coefficients, i.e. to disentangle quantity and factor price effects.

of the value added coefficients and trade vector which results in the following exposition:

$$\begin{aligned}\mathbf{T}_V^1 &= \begin{pmatrix} v^1 & 0 & 0 \\ 0 & v^2 & 0 \\ 0 & 0 & v^3 \end{pmatrix} \begin{pmatrix} l^{11} & l^{12} & l^{13} \\ l^{21} & l^{22} & l^{23} \\ l^{31} & l^{32} & l^{33} \end{pmatrix} \begin{pmatrix} x^{1*} & 0 & 0 \\ 0 & -x^{21} & 0 \\ 0 & 0 & -x^{31} \end{pmatrix} \\ &= \begin{pmatrix} v^1 l^{11} x^{1*} & -v^1 l^{12} x^{21} & -v^1 l^{13} x^{31} \\ v^2 l^{21} x^{1*} & -v^2 l^{22} x^{21} & -v^2 l^{23} x^{31} \\ v^3 l^{31} x^{1*} & -v^3 l^{32} x^{21} & -v^3 l^{33} x^{31} \end{pmatrix}\end{aligned}$$

The first matrix contains the value added coefficients of the three countries, the second matrix denotes the elements of the Leontief inverse from the global input-output matrix and the last matrix contains exports of country 1 and imports of country 1 from the other countries which are included as negative values. Summing up this matrix over rows and columns therefore gives a measure of net trade of value added for country 1. One should note however that this also includes indirect flows of value added and imports and it is therefore advisable to discuss the entries in these matrix separately. This will also document the decomposition of value added exports and imports in its various forms.

- *Exports:* The first column in matrix $\mathbf{T}_V^1$ describes value added exports of country 1.
  - *Domestic value added content of exports*: The first entry, $v^1 l^{11} x^{1*}$, denotes total direct and indirect value added exports of country 1 to all other countries.
  - *Foreign value added content of exports*: The production of these exports also requires inputs from other countries. For production of these inputs - used to produce exports of country 1 - value added in the other countries is created. This is captured by the remaining terms in the first column by partner country, i.e. $\sum_{p,p\neq 1} v^p l^{p1} x^{1*}$. Note, that this is added to value added exports of country 1, though value added is created in the other countries.
- *Imports*: The other columns capture the value added content of country 1's imports.
  - *Foreign value added content of bilateral imports*: The exports of country 2 to country 1 embody value added from the second country. Thus the second term in the second column captures country 1's value added imports from country 2. Similarly, the third entry in the third column captures the value added imports from country 3. Generally, the elements of the diagonal in the import block contain bilateral value added imports, $-\sum_{p\neq 1} v^p l^{pp} x^{p1}$.

- $*$ *Re-Imports*: Exports of country 2 to country 1 can also require inputs from country 1 itself. Therefore, the first entry in column 2 captures value added imports of country 1 embodied in imports from country 2; analogously for the third term in the first row. Total re-imports of value added are therefore $-\sum_{p\neq 1} v^1 l^{1p} x^{p1}$.
- $*$ *Foreign multilateral value added content of imports*: Country 2's exports to country 1 also require inputs from other countries. Thus, for example the entry in row 3 of column 2 captures the value added imports of country 1 from country 3 which are embodied in imports from country 2. An analogous interpretation holds for the entry in row 2 of column 3. Thus, the total amount of these imports is given by $-\sum_{p,q,p\neq q;p,q\neq 1} v^q l^{qp} x^{p1}$.

Analogous interpretations would also hold for countries 2 and 3 and generally for N countries. To disentangle these five components of net value added trade for country 1 it is convenient to rewrite the sum of the equation in the following way:

$$t_V^r = \underbrace{\underbrace{\sum_{s,s\neq r} v^r l^{rr} x^{rs}}_{\text{Domestic}} + \underbrace{\sum_{s,s\neq r}\sum_{p,p\neq r} v^p l^{pr} x^{rs}}_{\text{Foreign}}}_{\text{Value added content of exports}} - \underbrace{\Big(\underbrace{\sum_{p\neq r} v^p l^{pp} x^{pr}}_{\text{Bilateral}} + \underbrace{\sum_{p,q,p\neq q;p,q\neq r} v^q l^{qp} x^{pr}}_{\text{Re-imports}} + \underbrace{\sum_{r\neq p} v^r l^{rp} x^{pr}}_{\text{Multilateral}}\Big)}_{\text{Value added content of imports}} \quad (1)$$

There is a close relationship of this measure to others on vertical specialization already existing in the literature. Koopman et al. (2010) sorts out the measures as supposed by Hummels et al. (2001), Johnson and Noguera (2009) and Daudin et al. (2009) and provided an explicit derivation of the VS1 measure as supposed by Hummels et al. (2001). Relying on these results we can interpret the five terms in the above equation accordingly: The first term is country 1's domestic value added in direct exports, the second is the 'true' VS1[1] measure capturing the import content of exports (see Hummels et al., 2001; Koopman et al., 2010), the third term are country 1's direct imports of value added or the other countries' direct exports of value added to country 1 (where each import of country 1 is valued with the trading partner's value added coefficients), the fourth term is the VS1^{*1} measure capturing the re-imported value added of exports (see Daudin et al., 2009; Koopman et al., 2010) and the last term are country 1's indirect value added imports through third countries which is therefore the sum of VS1^p measures (see Hummels et al., 2001) where this was derived as value added exports through third countries (see also Koopman et al., 2010, where this was derived explitely).

Extending the above framework to many sectors requires only some slight modifications in the dimensionality of the matrices involved. Let N denote the number of countries and G the number of industries. $\mathbf{T}_V^r = \hat{\mathbf{v}}'\mathbf{L}\hat{\mathbf{t}}^r\ \mathbf{v}$ is now a $NG \times 1$ matrix, the Leontief inverse $\mathbf{L}$ is of dimension $NG \times NG$ and $\mathbf{t}^r$ is of dimension $NG \times 1$; with sector specific information on exports (to all countries) and sector specific information of imports from individual countries. Calculations can then be performed in exactly the same way as indicated above with additionally summing up over industries.[5] To derive country specific results one first has to add up block-wise. Thus the algebra has to be rewritten in the following way with $\mathbf{R} = \mathbf{I} \otimes \boldsymbol{\iota}$ and $\mathbf{S} = \mathbf{R}'$ denoting summation matrices where $\mathbf{I}$ is the identity matrix of dimension $N \times N$ and $\boldsymbol{\iota}$ denoting a vector of ones of dimension $G \times 1$; $\otimes$ denotes the Kronecker symbol. Matrix $\mathbf{R}$ is therefore of dimension $NG \times N$. Pre- and post-multiplying the industry specific matrix $\mathbf{T}_V^r$ which is of dimension $NG \times NG$ by $\mathbf{S}$ and $\mathbf{R}$ respectively, results in a matrix of dimension $N \times N$ which has the same interpretation as above (having however incorporated industry-specific interrelations).

2.2 Trade balance in value added and gross trade

Following this approach allows us to show the relationship between a country's trade balance in gross and value added trade. This is important to look at in detail as in many instances case studies show that a country is running a trade deficit in gross terms of a particular product whereas when taking account of intermediates trade, or considering trade in value added, the trade deficit in value added term is lower or even turns into a trade surplus (see e.g. Linden et al., 2009; Xing and Detert, 2010).

Based on the framework introduced above it can easily be shown that a country's net trade in value added equals net trade from gross exports and imports (see also Johnson and Noguera, 2009, where this is shown in a 2×2 example) From an intuitive point it is clear that total exports in value added of a country must be imported in another country (as all exports of goods must be imported somewhere else). As trade in goods is traced back to primary factor inputs and rewards and the coefficients of direct and indirect value added creation in a closed system is equal to one the trade deficit of a country equals the deficit measured in value added. Thus, this equality is a consequence of national accounting identities in a closed system of world trade. Further, as we view trade deficits from the viewpoint of individual countries we consider exports and imports as a form of final (exogenous) demand.

From an algebraic point of view this can be shown relatively straightforward. The vector of value added, which we will denote by $\mathbf{va}$, can be expressed in the following way from which value added

[5] This will further allow us to provide industry or industry-group specific results.

coefficients can easily be derived. Value added is gross output minus intermediate inputs, $\mathbf{va} = \mathbf{q} - \hat{\mathbf{q}}\mathbf{A}'\boldsymbol{\iota}$. Expressed in relation to gross output yields

$$\hat{\mathbf{q}}^{-1}\mathbf{va} = \mathbf{v} = \hat{\mathbf{q}}^{-1}\mathbf{q} - \hat{\mathbf{q}}^{-1}\hat{\mathbf{q}}\mathbf{A}'\boldsymbol{\iota} = \boldsymbol{\iota} - \mathbf{A}'\boldsymbol{\iota}$$

and therefore $\mathbf{v}' = \boldsymbol{\iota}'(\mathbf{I} - \mathbf{A})$. Inserting into our equation for measuring net trade in value added we get

$$t_V^{\text{net}} = \mathbf{v}'\big(\mathbf{I} - \mathbf{A}\big)^{-1}\mathbf{t} = \boldsymbol{\iota}'\big(\mathbf{I} - \mathbf{A}\big)\big(\mathbf{I} - \mathbf{A}\big)^{-1}\mathbf{t} = \boldsymbol{\iota}'\mathbf{t} = t^{\text{net}}$$

i.e. net trade in value added equals net trade in goods and services. Similarly one can show (by using trade vectors consisting of the export cell or the import cells) that the ratio of value added exports (imports) to gross exports (imports) equals one. The reason for this result is that in this framework all goods (intermediates and final goods) are produced by capital and labor as the only two primary factors which capture all the value added.

Thus one has carefully to consider the results that a country's trade deficit in value added might be lower than in terms of gross trade when considering bilateral flows. This might be the case in a bilateral relationship though it is not true when taking trade with all countries into account.[6]

2.3 Trade in factors

Instead of doing the analysis with the vector of value added coefficients $\mathbf{v}$ we can now exploit the fact that value added is a composite of income of various factors. Thus given data at hand one might split up each element of the value added coefficients vector into subcomponents like labor and capital, i.e. $v_i^r = \sum_f v_{i,f}^r$ where f denotes the factors considered. The data set at hand which are described below in more detail allows us to distinguish first between labor and capital income. The former can be split into three categories by educational attainment levels according to ISCED classification (high, medium, and low educational attainment) and the latter into ICT and Non-ICT capital. This means that we can differentiate trade in value added into trade in capital and labor and the respective categories. These individual factors of value added trade then sum nicely up to the aggregate as described above. Importantly, this allows then to consider in which factors a country is running a trade deficit or surplus. As we will see a country which is running a trade deficit can nonetheless be a net exporter of a particular factor like high-educated labor.

[6] This point is also made by **?**. This is in more detail considered in Foster and Stehrer (2011).

Summarizing, this approach of measuring net trade in value added is consistent with measures of net trade in gross terms, incorporates other measures as suggested in the recent literature and allows for a decomposition of value added trade along various dimensions which we document in subsequent sections.

3 Socio-economic accounts and World Input-Output Tables

In this section we provide information on a new database that is used to study the factor content of value added trade. For our analysis, we require a dataset on output and the use of production factors by industry including intermediates, as well as a dataset on bilateral trade flows at the same level of industry detail. The former set of data is obtained from Socio-Economic Accounts (SEAs), whereas the latter is derived from national input-output or supply and use tables which are combined into World Input-Output Tables (WIOTs) by use of bilateral trade data. Both datasets can be integrated in an empirical analysis, because we use the National Accounts framework. The information is collected on an annual basis from 1995 to 2006 at a detailed 35 industry level, but may also provide higher level aggregates. The industry classification follows the ISIC revision 3 classification (which is compatible to NACE revision 1.1; see appendix tables for a list of htese industries). Together, the GDP of the 40 countries covered in the database account for about 85 percent of world GDP. The variables from the SEAs include gross output and value added, final demand expenditures, as well as employment by education attainment, and capital compensation. The WIOTs are a combination of national input-output tables in which the use of products is broken down according to their origin. The remainder of this section provides an overview of the construction of the SEAs and the WIOTs.

3.1 Socio-Economic Accounts

The SEAs have largely been constructed on the basis of data from national statistical institutes (NSIs) and processed according to harmonized procedures. These procedures were developed to ensure international comparability of the basic data and to generate socio-economic accounts in a consistent and uniform way. Cross-country harmonization of the basic country data has focused on a number of areas including a common industrial classification, consistent definitions of various labor and capital types, and the use of similar price concepts for inputs and outputs. Importantly, this database is rooted in statistics from the National Accounts and follows the concepts and conventions of the System of National Accounts (SNA)

framework, and its European equivalent (ESA), in many respects. As a result, the basic statistics can be related to the national accounts statistics published by NSIs, although with adjustments that vary by group of variables considered: output and intermediate inputs, labor input and capital input.

Nominal and price series for output, intermediate inputs, and value added at the industry level are taken directly from the National Accounts. As these series are often short (as revisions are not always taken back in time) different vintages of the national accounts were bridged according to a common link-methodology. In cases where industry detail was missing, additional statistics from censuses and surveys were used to fill the gaps.

Labor service input is based on series of employment and wages of various types of labor. These series are not part of the core set of National Accounts statistics published by NSIs; typically only total employment and wages by industry are available from the National Accounts. For these series additional material has been collected from employment and labor force statistics. We cross-classify employment by educational attainment. For each country, a choice was made of the best statistical source for consistent wage and employment data at the industry level. In most cases this was the labor force survey (LFS), which in a number of cases was combined with earnings surveys as wages often are not included in the LFS. In other instances, an establishment survey, or social-security database was used (Timmer et al., 2007; Erumban et al., 2011).

Most employment surveys are not designed to track developments over time and breaks in methodology or coverage frequently occur. Therefore, care has been taken to arrive at series which are time consistent. Further, labor compensation of self-employed is not registered in the National Accounts, which, as emphasized by Krueger (1999), leads to an understatement of labor's share. We make an imputation by assuming that the compensation per hour of self-employed is equal to the compensation per hour of employees. This is especially important for industries which have a large share of self-employed workers, such as agriculture, trade, business and personal services. Also, we assume the same labor characteristics for self-employed as for employees when information on the former is missing. These assumptions are made at the industry level. Finally, capital compensation is derived as gross value added minus labor compensation.

3.2 World Input-Output Database

In this section we outline the basic concepts and construction of our world input-output tables (WIOTs). Basically, a WIOT is a combination of national input-output tables in which the use of products is broken

down according to their origin. Each product is produced either by a domestic industry or by a foreign industry. 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.

As building blocks for the WIOTs, we use national supply and use tables (SUTs) that are the core statistical sources from which NSIs derive national input-output tables. SUTs are a natural starting point as they provide information on both products and industries. Supply tables provide information on products produced by each domestic industry and use tables indicate 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.

To ensure meaningful analysis over time we start from industry output and final consumption series as described above, and benchmark national SUTs to these time-consistent series. Typically, SUTs are only available for a limited set of years 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.[7] 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) which is akin to the well-known bi-proportional (RAS) updating method for input-output tables as described in Temurshoev and Timmer (2011).

Next, to split the use of domestic production and imports, we rely on 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. The allocation follows from a revised classification of Broad Economic Categories (BEC) as made available from the United Nations Statistics Division (see Pöschl and Stehrer, 2010). As yet no standardized database on bilateral service flows exists. Services trade data from Balance of Payments statistics have been collected from various sources (including OECD, Eurostat, IMF and WTO), checked for consistency, and integrated into a bilateral service trade database (Francois and Pindyuk, 2010).

International SUTs were constructed using this bilateral trade data by use category. We start from the import vector provided in the supply tables. Import values for each country and product are split up

[7] Indonesia, Japan, Korea, and Taiwan only provide input-output tables which have been transformed back into supply and use tables. As a result, we have no information on secondary production in the supply tables for these countries.

into the three use categories. Next, within each use category a proportionality assumption is applied to split up the imports for each use category across the relevant dimensions. Investment are allocated only to gross fixed capital formation (i.e. not considering changes in inventories and valuables). This resulted in an import use table for each country, where each cell of the import use table is then split up by country of origin.

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 Eurostat, 2008). For the period from 1995 to 2006, this results in a WIOT for 40 countries and 35 industries, i.e. the intermediates demand block is of dimension 1400×1400, plus the additional rows on value added and columns on final demand categories.[8]

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 tables.

In the next section we present figures for individual countries grouping them into EU-15, EU-12 plus Turkey, NAFTA (Canada, USA and Mexico), Asian countries (Japan, Korea and Taiwan), and the BRIICs (Brazil, Russia, India, Indonesia and China) to which we also add Australia and Rest of World. One should note however that all calculations are performed at the level of individual countries and industries thus taking all available information into account.[9]

4 Patterns of trade in value added and factors

In this section we present selected results on the patterns of value added by applying equation (2.1). For this we proceed in a series of steps: First, we present the magnitudes of gross and value added exports and imports and the corresponding net figures for the 41 countries. We then split up trade in value added to its foreign and domestic contents. Finally, Trade in value added is then differentiated by factors. We report results for the years 1995, 2000 and 2005.

[8]The Rest of the World (RoW) is not explicitly modeled in this case but appears only in the import matrices by country (imports from RoW by product and industry) and export column (exports to rest of the world). We assume the structure of the input coefficients for the RoW is similar to the average coefficients from Brazil, China, India, Indonesia, and Mexico.

[9]We do not provide industry-level details here which is postponed for future research.

4.1 Trade balances

Table 1 reports the figures for exports and imports of goods and services in gross terms in billions of US dollars. As the value of a country's exports or imports is made of all value added in the stages of production this also equals trade in value added terms. Therefore net gross trade also equals net value added trade for a country.

First, in all countries the magnitude of exports and imports increased quite strongly, particularly for countries in the EU-12 where figures are three times higher on average in 2005 compared to 1995 and in China where the exports increased by a factor of five and imports by a factor of 4.8. The last three columns present net trade figures where a negative sign implies that this country is a net importer and a positive sign that it is a net exporter. Within the EU-15 countries some countries like France and Italy became net imports and for a number of other countries the trade balance worsened (e.g. Greece, Portugal, Spain, United Kingdom). The other countries show rather stable or even increasing positive net exports, particularly so for Germany. Austria switched from a deficit to a surplus. Most of the new member states show trade deficits with trends rather mixed across countries. For example, Poland turned from slightly positive in 1995 to strongly negative in 2000 but reduced the deficit again in 2005 whereas Romania shows a worsening trade balance. Turkey also shows a worsening trade balance over time. One can also clearly see the rising trade deficit of the US which amounted to more than 700 billion US dollars in 2005 and the rapidly rising trade surplus of China. Net trade for the European countries has been or has slipped into the negative for all years and country groups. The EU-15 in particular turned a trade surplus of around 65 billion US dollars into a trade deficit of similar magnitude. The Asian countries, Japan, Korea and Taiwan, and the other countries all show a trade surplus over this period with the only exception being Australia in 2005 and Brazil. An important distinction with respect to production networks and trade in value added might be to differentiate between trade in intermediates and final goods. Let us therefore start with some stylized facts about trade in intermediates and final goods summarizing a few results on the relative importance and patterns of trade in intermediates which are the vehicle for international supply chains. We present only a short overview of some important stylized facts with respect to trade in intermediates as compared to trade in final products, however with an emphasis on the former category (see also Chen et al., 2005; Miroudot et al., 2009). This is based on detailed trade data as outlined below. A more detailed analysis for the EU countries can be found in Stehrer et al. (2010). The figures presented here are based on the data used for the construction of the WIOD database. We emphasize this as the notion of "supply chains" - as often emphasized in case

Table 1 Trade in goods and services and trade in value added, in bn US-$

	(Value added) Exports			(Value added) Imports			Net trade		
Reporter	1995	2000	2005	1995	2000	2005	1995	2000	2005
Austria	68.5	76.4	141.2	-77.8	-78.5	-139.3	-9.3	-2.1	1.9
Belgium	177.2	174.7	284.8	-165.1	-167.6	-270.3	12.0	7.1	14.4
Denmark	60.3	65.8	109.8	-55.5	-58.7	-101.7	4.8	7.1	8.1
Finland	44.2	49.7	75.6	-35.5	-39.3	-68.7	8.7	10.4	6.9
France	323.5	333.3	495.9	-316.8	-338.0	-532.3	6.7	-4.7	-36.4
Germany	556.1	592.7	1071.9	-515.6	-561.9	-895.9	40.5	30.8	176.0
Greece	9.0	15.2	27.2	-28.8	-40.8	-69.7	-19.7	-25.6	-42.5
Ireland	45.6	87.6	155.6	-38.5	-75.4	-132.2	7.1	12.2	23.4
Italy	255.1	262.5	413.5	-231.4	-269.3	-437.4	23.8	-6.8	-23.8
Luxembourg	19.4	26.3	50.9	-16.3	-23.7	-44.9	3.1	2.6	5.9
Netherlands	218.7	220.7	358.5	-197.6	-202.6	-313.3	21.1	18.1	45.2
Portugal	26.6	27.4	43.3	-37.1	-43.3	-65.8	-10.5	-15.9	-22.5
Spain	105.9	135.0	236.0	-127.2	-178.3	-331.4	-21.3	-43.3	-95.3
Sweden	92.0	105.0	162.5	-77.0	-90.9	-138.9	15.0	14.2	23.6
United Kingdom	289.0	361.4	535.8	-295.4	-387.8	-606.0	-6.5	-26.4	-70.2
Bulgaria	5.7	6.6	14.6	-5.3	-6.8	-18.3	0.4	-0.2	-3.7
Cyprus	1.8	1.9	2.6	-2.0	-2.1	-3.6	-0.1	-0.2	-1.0
Czech Republic	24.5	32.5	83.9	-28.0	-35.7	-82.6	-3.5	-3.1	1.3
Estonia	2.4	4.1	9.5	-2.5	-4.0	-10.0	-0.0	0.1	-0.5
Hungary	14.9	28.6	67.4	-17.6	-32.6	-71.2	-2.6	-4.0	-3.8
Latvia	1.9	3.1	6.6	-2.1	-3.7	-9.0	-0.2	-0.6	-2.5
Lithuania	2.5	4.3	11.8	-3.2	-5.1	-14.0	-0.8	-0.8	-2.2
Malta	1.1	1.4	1.7	-1.3	-1.6	-1.9	-0.2	-0.1	-0.2
Poland	30.0	43.7	108.7	-28.3	-55.4	-112.4	1.7	-11.8	-3.7
Romania	9.4	11.5	31.6	-11.9	-13.6	-42.1	-2.5	-2.1	-10.5
Slovak Republic	9.9	13.3	33.4	-10.5	-14.6	-37.0	-0.7	-1.3	-3.6
Slovenia	9.4	8.5	21.2	-9.2	-8.6	-20.3	0.2	-0.1	0.9
Turkey	27.7	39.7	80.2	-37.0	-57.2	-113.4	-9.3	-17.5	-33.2
Canada	206.7	312.0	406.6	-190.5	-273.3	-367.3	16.2	38.7	39.3
United States	711.0	937.5	1133.6	-844.2	-1354.3	-1855.1	-133.2	-416.8	-721.5
Mexico	75.7	162.8	211.0	-70.5	-174.1	-217.7	5.2	-11.3	-6.7
Japan	480.0	512.5	652.1	-390.1	-427.4	-566.1	89.8	85.1	86.0
South Korea	134.3	175.4	276.2	-128.3	-149.8	-237.5	6.0	25.6	38.7
Taiwan	125.8	161.8	217.6	-117.7	-149.5	-195.2	8.1	12.3	22.4
Australia	70.9	88.5	145.2	-69.9	-83.4	-148.9	1.0	5.1	-3.8
Brazil	51.8	58.4	123.2	-58.7	-64.6	-87.3	-6.9	-6.2	35.8
China	164.2	278.9	832.5	-129.4	-217.1	-615.4	34.9	61.7	217.1
Indonesia	52.7	62.6	96.4	-51.7	-45.2	-78.3	1.0	17.4	18.1
India	38.6	61.7	141.5	-34.6	-51.2	-129.2	4.0	10.5	12.3
Russia	79.6	103.0	235.2	-58.8	-47.0	-119.6	20.9	56.0	115.6
Rest of World	597.3	958.0	1570.3	-702.1	-772.3	-1375.8	-104.8	185.7	194.5

Source: WIOD database, Version January 2011; author's calculations

studies as mentioned above - is misleading when taking into account the fact that intermediate inputs (or components) are also themselves produced by various other inputs (intermediates and primary). Thus, though the notion of a supply chain might be relevant for particular products it does not properly account for the integrated nature of the whole production process (which might be better described as "supply loops" or the old notion of "roundaboutness" as discussed by Böhm-Bawerk (1888) for example.[10] In the literature other notions are also used such as 'modular production networks' (see e.g. Faust et al., 2004). For a discussion of supply chains and its conceptualizations see MacKechnie (2008) who proposes a discussion in terms of hierarchy, networks and markets. In essence, we point towards the fact that countries are both exporters and importers of intermediates even in narrowly defined industries which has to be taken into account when measuring trade in value added. For the sake of figuring out the value added content of a country's exports and imports one has to notice that also intermediates exports or imports embodies value added which has to be taken into account properly. A country's gross trade balance is resulting both from trade in final as well as trade in intermediate products.

When differentiating trade into end use categories it turns out that on average roughly fifty percent on average of total trade is traded intermediates whereas the remaining part is either for final consumption or gross fixed capital formation. Here one has to note that the category "intermediates" is rather broad including raw materials and agricultural goods, and in particular one has to mention that it is much broader than trade in parts and components which is often considered in the literature. These patterns are relatively stable over time but can be quite heterogenous across countries. Higher shares are mostly observed for emerging and transition economies and resource rich economies. A second issue is that trade in intermediates seems to be concentrated in particular industries. At the lower end industries such as 16 (tobacco products), 18 (Wearing apparel), 05 (fish and fishing products), 15 (food products and beverages), and 19 (leather and leather products) show little trade in intermediates. Amongst the industries with the highest shares are mining industries, basic metals (27) and secondary raw materials (37) having shares of around 100 percent. Industries for which parts and components trade is important are in the middle range. These patterns are fairly consistent across countries. Finally, it is worth mentioning that also for intermediates two-way trade is important, i.e. countries import and export the same intermediates in fairly detailed product categories similar to final goods trade (see e.g. Stehrer et al., 2011).

Table 2 presents the net trade figures when differentiating between these two categories from which we highlight a few interesting patterns. For example, Germany became a strong net exporter of inter-

[10] One should note however that the focus in this contribution was different; see also (Samuelson, 1966) for a critical assessment.

Table 2 Net trade in intermediates and final goods, in bn US-$

	Net exports intermediates			Net exports final goods		
Reporter	1995	2000	2005	1995	2000	2005
Austria	48.8	26.0	12.8	-58.1	-28.1	-10.9
Belgium	0.4	1.1	20.8	11.6	6.0	-6.3
Denmark	-2.5	3.4	3.0	7.4	3.7	5.1
Finland	10.6	12.5	9.6	-1.8	-2.1	-2.7
France	17.5	-26.3	-18.2	-10.8	21.6	-18.2
Germany	89.1	59.0	274.3	-48.6	-28.2	-98.3
Greece	6.6	-8.9	-8.8	-26.3	-16.6	-33.7
Ireland	-5.1	-1.7	22.4	12.2	13.9	1.0
Italy	-10.6	-16.2	-24.0	34.4	9.4	0.2
Luxembourg	-0.4	-9.3	3.4	3.5	11.9	2.5
Netherlands	13.2	13.4	40.2	7.8	4.7	5.0
Portugal	-6.3	-7.7	-9.5	-4.2	-8.2	-13.0
Spain	-28.0	-38.9	-70.1	6.8	-4.4	-25.2
Sweden	5.4	4.5	16.8	9.6	9.7	6.9
United Kingdom	2.2	-57.6	-17.0	-8.6	31.2	-53.2
Bulgaria	-0.0	0.0	-1.8	0.4	-0.2	-2.0
Cyprus	-0.5	0.1	2.9	0.4	-0.3	-3.9
Czech Republic	-2.1	0.9	-3.9	-1.4	-4.0	5.1
Estonia	-0.2	0.8	1.0	0.1	-0.7	-1.5
Hungary	-2.4	-6.9	-6.4	-0.2	2.9	2.6
Latvia	0.9	1.1	0.6	-1.1	-1.7	-3.1
Lithuania	-0.2	-0.8	-0.2	-0.6	-0.0	-2.0
Malta	0.3	0.3	1.0	-0.5	-0.5	-1.2
Poland	-0.2	-6.8	-9.5	1.8	-4.9	5.8
Romania	-3.4	-3.9	-5.7	0.8	1.8	-4.8
Slovak Republic	0.7	-1.4	-2.9	-1.3	0.1	-0.7
Slovenia	1.9	0.2	-0.6	-1.7	-0.3	1.5
Turkey	-12.6	-17.1	-31.4	3.3	-0.3	-1.8
Canada	38.7	91.6	143.5	-22.5	-52.9	-104.2
United States	43.3	-90.0	-377.9	-176.5	-326.8	-343.6
Mexico	-7.8	-40.7	-5.9	13.0	29.4	-0.8
Japan	46.2	10.7	8.9	43.6	74.4	77.1
South Korea	-8.9	-17.1	1.5	14.9	42.7	37.2
Taiwan	-15.0	-6.4	27.5	23.0	18.7	-5.0
Australia	20.8	47.6	89.4	-19.8	-42.5	-93.1
Brazil	10.6	-1.7	25.3	-17.5	-4.4	10.6
China	-35.1	-51.6	-54.5	69.9	113.3	271.6
Indonesia	0.2	14.3	29.7	0.8	3.1	-11.6
India	-5.9	-11.9	-12.1	9.9	22.5	24.4
Russia	32.5	46.5	167.3	-11.6	9.6	-51.6
Rest of World	-242.5	89.1	-241.3	137.6	96.6	435.8

Source: WIOD database, Version January 2011; author's calculations

mediates, whereas the trade balance with respect to final goods was always negative and even worsened. Similar dynamic patterns though at different levels might be observed for Belgium, Ireland, Luxembourg, Netherlands and Sweden. In other countries like Greece, Italy, Portugal, Spain and the United Kingdom both the trade balance with respect to intermediates and final goods worsened and in some cases turned from positive to negative. The remaining countries show somewhat distinct patterns. For the new member states the patterns are again rather mixed. Poland, for example, shows a negative and worsening balance in intermediates but surpluses in final goods trade, whereas Romania shows worsening patterns in both categories. Turkey is a strong net importer of intermediates with a small surplus in final goods trade in 1995 and 2000, which turned into negative in 2005. With respect to the NAFTA countries the US is similar to the second group above, with deteriorating negative balances in both intermediates (still positive in 1995) and final goods trade. Canada has a increasing surplus in intermediates trade but a worsening deficit in final goods trade, whereas Mexico was net importer of intermediates and net exporter of final goods though this has changed in 2005. The Asian countries show positive net trade in both categories in most cases though with different tendencies. For example, whereas in Japan the positive trade balance in intermediates declined, it increased in final goods trade, whereas for Taiwan one can see the oppositive pattern with even switching signs. In South Korea both balances increased and even turned into positive for intermediates trade. With respect to the remaining countries Australia, Brazil, Indonesia and Russia show positive balances for intermediates trade with in most cases deficits or much lower surpluses in final goods trade though tendencies over time are rather mixed (e.g. Brazil). India and particularly China show a negative balance in intermediates trade but strong and increasing surpluses in final goods trade.

These rather mixed patterns are driven on the one hand by the countries' endowments with natural resources (e.g. Australia, Russia) and its role in the global production process (e.g. China, Eastern European countries) and the sectoral structures. It would go beyond the scope of this paper to go into the details and determinants of these patterns, which are however important with respect to trade in value added to which we turn next.

4.2 Trade in value added

A country's exports contain however not only domestic value added but also foreign and analogously for imports. These shares can be disentangled using the approach outlined above. In Table 3 we present the shares according to our decomposition into the five components with respect to domestic and foreign

contents of value added trade. As countries become more and more integrated in to international production processes one would expect that the share of the foreign value added content of exports would be rising over time. Further, smaller countries would be expected to show higher values. In fact, this share was rising for almost all countries as reported in the first three columns of Table 3 with a few exceptions maybe and the magnitudes of change being rather different. For the EU-15 countries these shares range from less than 20 percent in the United Kingdom to more than 40 percent in Belgium, Ireland, and Luxembourg. There have been particularly strong increases for Eastern European countries, which show particularly high shares in most cases comparable to Taiwan , and Turkey. In the former group the shares range from 30-40 percent in most cases in 2005. For comparison, the share of Taiwan is also at 40 percent and for South Korea at 30 percent. In this country group, Japan has the lowest shares with 12 percent in 2005 which is much lower than the shares for large European countries like Germany (23 percent) and the UK (19 percent) but in the range of the US with 13 percent in 2005 rising from 10 percent in 1995. Canada and Mexico show shares around 25 percent which are in the range of China in 2005. For this country the shares increased from 14.5 percent in 1995. The other countries tend to have lower shares ranging from less than 10 percent in Russia to about 17 percent in Indonesia, Thus, with respect to exports these results confirm the other literature of an increasing internationalization of production pointing towards the fact that smaller countries tend to have larger shares and the rapid integration of Eastern European countries. Turning to the import side, the shares of re-imports are fairly small with a mixed tendency over time. Some significant magnitudes can be found for Germany and the US. Analogously to the exports, we would also expect that the share of foreign imports of value added would rise as the imports from other countries increasingly embody value added from third countries. Again this is what is actually found (see three last columns in Table 3). It is interesting to note that the the shares are much more similar across countries pointing towards the fact that bilateral relations are more important. Splitting up into final goods and intermediates it turns out that the shares by use category are not too different for the individual countries though there are some notable exceptions. Particularly, the shares of the foreign multilateral content of VA imports tend to be lower for the more advanced countries. The reason for this is that these countries' shares in bilateral content of VA imports of intermediates are high because of imports of raw materials (also from the rest of the world). Importantly however, in most cases these shares are increasing over time both for final and intermediates goods trade which implies that the production of intermediates goods trade has also become more integrated over time.[11]

[11] Results are available upon request.

Table 3 Decomposition of total value added trade (in %)

	Foreign VA content of exports			Re-Imports of VA			Foreign VA content of multilateral imports		
Reporter	1995	2000	2005	1995	2000	2005	1995	2000	2005
Austria	22.1	27.0	31.1	0.8	0.9	0.7	18.7	22.9	25.3
Belgium	39.1	43.6	43.6	0.9	0.8	0.9	19.8	23.1	25.2
Denmark	24.8	29.8	32.0	0.3	0.6	0.7	22.5	23.1	24.9
Finland	21.9	26.0	28.9	0.4	0.6	0.5	17.0	21.5	23.7
France	18.2	23.1	23.0	2.0	1.7	1.8	19.0	22.2	25.1
Germany	16.0	21.4	23.1	4.0	3.9	5.2	18.5	21.6	23.9
Greece	18.2	24.3	22.3	0.1	0.1	0.2	19.4	20.1	24.0
Ireland	39.1	47.4	42.8	0.2	0.2	0.2	18.0	16.0	16.1
Italy	17.3	19.3	20.3	1.2	1.3	1.4	18.9	21.5	24.2
Luxembourg	45.3	58.5	59.8	0.1	0.1	0.1	19.7	17.2	17.4
Netherlands	31.2	34.3	34.0	1.1	1.0	1.4	16.8	18.9	21.8
Portugal	25.4	27.7	28.3	0.2	0.2	0.3	18.8	23.5	24.5
Spain	19.3	25.4	24.8	0.6	0.7	0.8	19.7	22.6	24.1
Sweden	24.8	29.3	29.9	0.7	0.6	0.7	21.8	22.3	25.4
United Kingdom	19.0	19.0	18.6	1.5	1.5	1.5	19.7	23.1	24.6
Bulgaria	29.4	36.9	42.0	0.1	0.0	0.1	17.0	21.0	26.2
Cyprus	25.0	28.4	24.0	0.0	0.0	0.0	20.8	21.2	23.0
Czech Republic	29.1	37.7	43.1	0.8	0.5	0.5	19.8	23.9	27.0
Estonia	36.2	44.0	42.8	0.1	0.1	0.1	21.3	23.8	26.1
Hungary	27.6	47.3	45.8	0.1	0.2	0.3	18.5	24.1	27.4
Latvia	25.2	27.6	31.0	0.1	0.1	0.2	22.0	25.7	29.0
Lithuania	32.2	33.1	35.0	0.1	0.1	0.2	19.0	20.6	23.3
Malta	47.1	52.3	44.0	0.0	0.0	0.0	20.7	25.1	24.4
Poland	16.1	22.3	28.9	0.2	0.3	0.4	19.8	24.8	25.9
Romania	25.0	26.6	29.5	0.0	0.1	0.1	19.4	23.4	25.4
Slovak Republic	32.1	43.8	46.2	0.7	0.3	0.3	21.4	24.3	28.4
Slovenia	30.7	34.5	38.7	0.1	0.1	0.1	22.1	26.8	30.5
Turkey	12.8	18.1	22.5	0.1	0.2	0.2	19.5	23.6	25.5
Canada	25.1	26.9	23.1	1.3	1.9	2.0	12.6	13.7	16.8
United States	9.7	11.0	13.3	6.9	8.6	6.2	13.1	14.4	17.9
Mexico	22.6	27.7	25.9	0.5	0.8	0.9	13.0	15.3	21.0
Japan	6.6	8.9	12.1	2.2	2.2	2.1	13.1	15.9	18.6
South Korea	22.7	28.6	30.5	0.5	0.6	0.8	13.6	14.2	18.4
Taiwan	31.0	34.1	40.4	0.3	0.5	0.8	12.1	14.7	17.7
Australia	11.3	12.4	12.0	0.3	0.5	0.7	15.8	17.7	22.3
Brazil	6.8	9.7	9.8	0.4	0.2	0.3	16.2	17.5	20.7
China	14.5	15.9	23.0	0.6	1.1	2.7	16.8	20.1	22.7
Indonesia	15.8	18.3	16.8	0.2	0.4	0.5	16.3	15.6	20.2
India	7.7	11.0	14.0	0.1	0.2	0.5	16.0	16.1	22.1
Russia	7.4	9.0	6.4	0.8	0.8	1.3	20.0	21.1	23.5
Rest of World	21.4	18.0	24.3	1.2	3.0	3.3	12.4	10.8	12.5

Source: WIOD database, Version January 2011; author's calculations

4.3 Trade in factors

Trade in value added is itself composed of trade in capital and labor as outlined above. From a theoretical perspective the HOV results suggest that countries being abundant with labor (capital) would be net exporters of labor (capital) services at least in productivity adjusted terms. As in this paper we focus on trade in value terms (rather than in physical units) this picture becomes distorted as we allow for differences in factor rewards (i.e. no factor-price equalization).[12] However, the picture is already distorted when allowing for trade in intermediates or 'trade in tasks' (see Baldwin and Robert-Nicoud, 2010).

4.3.1 Capital and labor

Table 4 presents the results when using capital and labor coefficients instead of value added coefficients. As the former two sum up to the latter trade flows in capital and labor must also sum up to flows in value added terms. In the EU-15 most countries with only a few exceptions (Finland, Ireland, Luxembourg, Sweden) are net importers of capital with the deficit rising in most cases. The reason behind is probably the rising raw material prices showing up as capital income. A number of countries however are net exporters of labor and have become increasingly so: Austria, Belgium, Denmark, Germany, Netherlands, and Sweden show rising trade surpluses with respect to labor whereas for Finland, France, Italy, Luxembourg, and the UK the surplus is rather stable or fluctuates. For the other countries one can observe deficits which are rising in some cases like Greece and Spain. The Eastern European countries are almost without exception net importers of capital. With respect to labor the evidence is rather mixed. For example the Czech Republic and Slovenia show a surplus at least in 2005 whereas Hungary, Poland, Romania and Slovak Republic showing a negative balance. Turkey is both a net importer of capital and labor and increasingly so.

For the NAFTA states the evidence is again rather mixed. Canada is running a trade surplus both in labor and capital with the surplus in capital being much larger. The US is running a deficit which is increasing quite rapidly in both categories. Particularly, for capital the deficit went from positive (125.3 in 1995) to strongly negative (-454.1 in 2005); with respect to labor the US has been a net importer over the whole period but again this worsened from -7.9 in 1995 to -267.3 in 2005. Mexico was a net exporter of capital and became a net importer of labor which is somewhat surprising requires a more thorough analysis.

[12] This will be undertaken in future work along the lines testing the HOV model. This paper aims at some on trade in factors in value terms.

Table 4 Net trade in capital and labor (total trade), in bn US-$

	Net exports capital			Net exports labor		
Reporter	1995	2000	2005	1995	2000	2005
Austria	-6.7	-2.0	-2.5	-2.6	-0.1	4.4
Belgium	2.1	-2.9	-2.7	10.0	10.1	17.2
Denmark	0.2	1.8	-0.6	4.6	5.4	8.7
Finland	2.7	4.6	0.0	6.1	5.8	6.9
France	-24.8	-26.9	-69.8	31.5	22.2	33.4
Germany	-48.0	-56.2	-21.1	88.5	87.0	197.1
Greece	-7.6	-9.6	-15.4	-12.1	-16.0	-27.1
Ireland	5.5	14.2	25.1	1.7	-2.0	-1.7
Italy	-6.6	-16.7	-47.4	30.4	9.9	23.6
Luxembourg	2.1	1.9	2.8	1.0	0.7	3.1
Netherlands	3.1	-1.7	1.6	18.0	19.8	43.7
Portugal	-4.8	-8.0	-12.2	-5.7	-7.8	-10.3
Spain	-9.6	-22.2	-46.6	-11.7	-21.1	-48.7
Sweden	4.8	1.0	1.5	10.2	13.2	22.1
United Kingdom	-19.3	-50.0	-91.7	12.8	23.6	21.6
Bulgaria	-0.2	-0.5	-2.3	0.6	0.3	-1.4
Cyprus	-0.2	-0.2	-0.6	0.0	0.0	-0.4
Czech Republic	-0.6	-0.8	-0.4	-2.9	-2.4	1.7
Estonia	-0.1	-0.3	-0.8	0.0	0.4	0.3
Hungary	-1.8	-1.7	-2.6	-0.8	-2.3	-1.3
Latvia	-0.2	-0.5	-1.6	0.0	-0.1	-0.9
Lithuania	-0.7	-1.0	-2.2	-0.1	0.2	0.0
Malta	-0.1	-0.1	-0.1	-0.1	-0.0	-0.1
Poland	0.8	-4.3	2.2	0.9	-7.5	-5.9
Romania	-1.8	-2.0	-7.2	-0.7	-0.1	-3.4
Slovak Republic	0.6	-0.1	-0.9	-1.3	-1.2	-2.7
Slovenia	-1.2	-0.7	-0.8	1.4	0.5	1.7
Turkey	-6.8	-13.3	-28.0	-2.5	-4.1	-5.2
Canada	14.4	32.5	32.6	1.8	6.3	6.8
United States	-125.3	-306.7	-454.1	-7.9	-110.0	-267.3
Mexico	22.4	32.3	40.5	-17.2	-43.6	-47.2
Japan	12.0	-0.5	-2.4	77.9	85.6	88.5
South Korea	-10.1	1.4	-2.0	15.3	23.5	39.5
Taiwan	-3.1	1.3	-0.5	10.7	11.5	23.1
Australia	0.4	0.3	1.1	0.6	4.8	-4.8
Brazil	-0.3	0.2	21.7	-6.6	-6.3	14.1
China	16.0	26.7	100.0	18.8	35.1	117.2
Indonesia	13.5	21.2	24.8	-12.4	-3.9	-6.7
India	11.8	17.9	30.8	-7.8	-7.4	-18.4
Russia	29.1	49.6	111.5	-8.2	6.4	4.1
Rest of World	138.4	322.0	420.4	-242.1	-136.4	-225.2

Source: WIOD database, Version January 2011; author's calculations

All Asian countries have been strong net exporters of labor and increasingly so for South Korea and Taiwan and in most cases net importers of capital though the deficits are rather small. With respect to the remaining countries it turns out that these are net importers of labor in most cases with the exception of China and Russia. China shows a large and increasing surplus both for capital and labor. All countries in this group are also net exporters of capital with stronger increases of the surplus observed in Brazil, China, Indonesia, India and Russia.

Here it is important to differentiate between trade in intermediates and trade in final goods partly because trade in intermediates includes both raw materials and also high-tech components for example. We therefore show the trade balances in capital and labor differentiating between intermediates and final goods in Table 5. Let us highlight a few examples. On the one hand, countries exporting raw materials like Russia (oil), Australia (mining) and maybe Canada have increased the trade surplus in capital particularly in intermediates trade whereas the balance with respect to final goods worsened. This was similarly the case when looking at labor. On the other hand, countries like the US, UK, Italy, Japan and maybe also Turkey face larger and increasing trade deficits in intermediates with respect to capital in particular and in some cases also with respect to labor (e.g. US). China faces a large trade deficit in intermediates with respect to capital and labor with the former deteriorating over time. It however runs trade surpluses in final goods exports both with respect to capital and labor. Finally, Germany has a surplus in intermediates trade both in capital (apart from 2000) and labor, with the latter being much more important in magnitude. It runs a trade deficit in final goods trade with respect to capital but a surplus in final goods trade with respect to labor though this turned negative in 2005. A more detailed analysis of these pattern would require to look at the country specific patterns of trade with respect to the domestic and foreign contents in a bilateral way which has to be postponed to future analysis.

Table 6 presents however the components of value added trade with respect to the domestic and foreign content differentiating between capital and labor (we leave out the share of re-imports as this is rather small). Overall, these are quite similar to the ones for total trade and also the patterns across countries are quite similar. Again, the share of foreign value added content of exports tend to be larger and more disperse as compared to the share of the multilateral foreign value added content of imports. There is however no clear pattern of whether these shares are higher or lower for capital or labor across countries.

Table 5 Net trade in capital and labor by use categories, in bn US-$

	Net exports capital						Net exports labor					
	Intermediates			Final goods			Intermediates			Final goods		
Reporter	1995	2000	2005	1995	2000	2005	1995	2000	2005	1995	2000	2005
Austria	14.6	7.5	2.6	-21.3	-9.4	-5.1	34.1	18.5	10.2	-36.7	-18.7	-5.8
Belgium	-1.5	-4.3	0.6	3.5	1.3	-3.3	1.9	5.4	20.2	8.1	4.7	-3.0
Denmark	-1.9	1.1	-0.9	2.2	0.7	0.3	-0.6	2.3	3.8	5.2	3.1	4.9
Finland	3.7	5.5	1.6	-1.0	-0.9	-1.6	6.8	7.0	8.0	-0.8	-1.2	-1.1
France	-10.4	-25.3	-43.0	-14.4	-1.7	-26.8	27.9	-1.1	24.9	3.6	23.3	8.6
Germany	4.5	-14.8	59.8	-52.5	-41.4	-80.8	84.6	73.9	214.6	3.9	13.1	-17.5
Greece	2.4	-3.7	-4.2	-10.1	-5.9	-11.2	4.2	-5.2	-4.6	-16.3	-10.8	-22.5
Ireland	-0.0	8.0	23.0	5.5	6.2	2.1	-5.1	-9.7	-0.6	6.7	7.8	-1.1
Italy	-13.4	-17.7	-34.5	6.8	1.0	-12.9	2.8	1.4	10.6	27.6	8.5	13.1
Luxembourg	-0.4	-5.2	0.4	2.5	7.0	2.4	0.0	-4.1	3.0	1.0	4.9	0.1
Netherlands	4.2	0.7	5.6	-1.1	-2.5	-4.0	9.0	12.6	34.7	8.9	7.2	9.0
Portugal	-2.8	-4.3	-6.2	-2.0	-3.7	-6.0	-3.5	-3.4	-3.3	-2.2	-4.5	-7.0
Spain	-12.8	-19.6	-35.9	3.3	-2.6	-10.7	-15.2	-19.3	-34.2	3.5	-1.8	-14.5
Sweden	1.9	-0.6	0.6	2.9	1.6	0.9	3.5	5.1	16.1	6.7	8.1	6.0
United Kingdom	-9.0	-39.4	-43.0	-10.3	-10.5	-48.7	11.2	-18.2	26.0	1.7	41.7	-4.5
Bulgaria	-0.4	-0.4	-1.5	0.2	-0.1	-0.8	0.4	0.5	-0.3	0.2	-0.1	-1.1
Cyprus	-0.3	-0.1	1.1	0.1	-0.2	-1.7	-0.3	0.2	1.8	0.3	-0.1	-2.3
Czech Republic	-0.6	0.5	-2.5	0.0	-1.3	2.1	-1.5	0.4	-1.3	-1.4	-2.7	3.0
Estonia	-0.1	0.1	0.1	0.0	-0.4	-0.9	-0.1	0.7	1.0	0.1	-0.3	-0.6
Hungary	-1.8	-2.8	-4.1	-0.0	1.1	1.6	-0.7	-4.1	-2.3	-0.2	1.8	1.1
Latvia	0.2	0.2	-0.2	-0.4	-0.6	-1.3	0.7	0.9	0.8	-0.6	-1.0	-1.7
Lithuania	-0.3	-0.7	-1.1	-0.4	-0.2	-1.1	0.1	-0.1	1.0	-0.2	0.2	-0.9
Malta	0.1	0.1	0.3	-0.2	-0.2	-0.4	0.2	0.2	0.7	-0.3	-0.3	-0.7
Poland	-0.4	-2.8	-2.6	1.2	-1.5	4.8	0.3	-4.0	-6.9	0.6	-3.5	0.9
Romania	-1.9	-2.2	-4.7	0.1	0.1	-2.4	-1.5	-1.7	-1.0	0.8	1.6	-2.4
Slovak Republic	0.8	-0.4	-0.8	-0.2	0.3	-0.1	-0.2	-1.0	-2.2	-1.1	-0.2	-0.6
Slovenia	-0.4	-0.3	-1.1	-0.7	-0.3	0.3	2.4	0.5	0.5	-1.0	0.0	1.2
Turkey	-7.0	-11.0	-23.1	0.2	-2.4	-4.9	-5.6	-6.1	-8.4	3.1	2.0	3.2
Canada	23.6	48.3	73.9	-9.2	-15.9	-41.3	15.1	43.3	69.6	-13.3	-37.0	-62.9
United States	-29.0	-120.5	-251.6	-96.3	-186.2	-202.5	72.4	30.6	-126.2	-80.3	-140.6	-141.1
Mexico	9.6	5.2	29.1	12.8	27.1	11.4	-17.4	-45.8	-35.0	0.2	2.2	-12.2
Japan	-0.1	-24.4	-33.1	12.0	23.9	30.7	46.3	34.5	42.0	31.6	51.1	46.5
South Korea	-11.5	-12.9	-12.3	1.3	14.3	10.3	2.6	-3.7	13.9	12.7	27.2	25.6
Taiwan	-10.6	-5.5	2.6	7.5	6.8	-3.1	-4.8	-1.5	24.1	15.5	13.0	-1.0
Australia	13.5	28.2	59.0	-13.1	-27.9	-57.9	7.3	19.4	30.4	-6.7	-14.6	-35.2
Brazil	6.8	1.2	15.7	-7.1	-1.1	6.0	3.8	-2.9	9.5	-10.4	-3.4	4.6
China	-15.9	-26.8	-32.7	31.9	53.5	132.6	-19.2	-24.8	-21.8	38.0	59.8	139.0
Indonesia	7.6	16.1	30.2	5.9	5.1	-5.4	-7.3	-1.8	-0.5	-5.1	-2.1	-6.2
India	1.2	-1.8	5.3	10.7	19.7	25.4	-7.0	-10.1	-17.4	-0.8	2.7	-1.0
Russia	26.4	35.6	122.6	2.7	14.0	-11.1	6.1	10.9	44.7	-14.3	-4.5	-40.5
Rest of World	11.4	189.3	105.2	127.0	132.7	315.2	-253.5	-99.8	-346.0	11.5	-36.6	120.8

Source: WIOD database, Version January 2011; author's calculations

Table 6 Decomposition of trade in factors (total trade), in %

	Capital						Labor					
	Foreign VA content of exports			Foreign VA content of imports (multilateral)			Foreign VA content of exports			Foreign VA content of imports (multilateral)		
Reporter	1995	2000	2005	1995	2000	2005	1995	2000	2005	1995	2000	2005
Austria	26.1	28.6	33.3	19.2	25.4	28.4	19.9	26.1	29.7	18.4	21.3	23.1
Belgium	41.8	49.0	49.4	21.8	24.5	25.6	37.6	40.3	39.4	18.7	22.0	24.9
Denmark	27.0	31.9	36.0	24.0	24.2	26.6	23.5	28.5	29.4	21.6	22.4	23.7
Finland	23.7	26.7	33.4	17.8	22.6	23.5	20.8	25.5	25.8	16.5	20.8	23.9
France	23.2	28.1	31.0	19.7	23.2	26.6	15.9	20.4	19.1	18.5	21.5	23.9
Germany	23.0	30.0	29.9	19.2	22.5	25.3	13.1	17.4	19.4	17.9	21.0	22.8
Greece	19.6	23.0	20.4	20.5	21.2	25.6	17.4	25.4	24.4	18.7	19.4	22.9
Ireland	34.0	35.3	33.8	20.1	19.5	18.8	43.1	57.9	51.5	16.7	14.1	14.4
Italy	20.9	22.6	26.5	19.2	22.0	24.6	15.5	17.3	16.9	18.6	21.2	23.9
Luxembourg	44.9	59.8	63.9	19.2	16.5	17.1	45.6	57.2	56.1	20.0	17.8	17.6
Netherlands	33.7	39.4	40.0	18.5	19.8	22.5	29.9	31.2	30.1	15.8	18.2	21.2
Portugal	27.3	32.5	33.5	19.7	24.9	26.3	24.3	25.1	25.3	18.3	22.5	23.2
Spain	19.8	27.9	27.0	20.0	23.1	25.3	19.0	23.9	23.3	19.5	22.2	23.2
Sweden	25.2	32.6	34.9	23.4	24.4	26.8	24.5	27.4	26.9	20.7	20.9	24.3
United Kingdom	22.5	26.0	26.1	19.7	23.0	25.9	17.1	15.7	15.0	19.7	23.2	23.6
Bulgaria	37.8	48.5	51.1	14.8	19.3	27.8	23.5	28.8	35.9	19.1	22.5	24.9
Cyprus	31.4	38.0	31.4	20.9	20.9	24.2	21.5	22.7	19.6	20.8	21.5	22.2
Czech Republic	28.4	36.1	44.3	21.4	26.6	29.3	29.5	38.8	42.2	18.8	22.2	25.3
Estonia	39.5	54.6	50.6	22.2	20.8	26.9	34.2	36.9	37.9	20.7	26.7	25.5
Hungary	32.6	47.1	47.0	18.3	25.6	29.3	24.5	47.4	44.9	18.7	23.0	26.0
Latvia	30.3	34.3	39.9	22.2	27.1	31.5	22.2	23.8	25.9	21.8	24.6	27.0
Lithuania	43.9	48.6	49.1	16.8	18.4	21.3	25.1	24.2	25.5	21.1	22.8	25.4
Malta	46.7	57.4	47.6	23.1	26.6	28.9	47.3	49.1	41.9	19.4	24.0	21.6
Poland	16.7	21.9	27.1	19.9	26.9	27.0	15.6	22.5	30.5	19.8	23.4	25.0
Romania	33.1	35.8	38.2	19.5	23.5	26.2	20.9	22.0	24.6	19.3	23.2	24.7
Slovak Republic	28.1	41.9	44.2	20.9	23.7	27.2	36.3	45.6	48.2	21.7	24.7	29.5
Slovenia	46.9	42.2	45.1	23.5	28.6	33.2	25.1	30.5	34.9	21.3	25.6	28.4
Turkey	18.4	27.4	34.3	19.0	22.9	24.4	10.2	13.9	16.7	19.9	24.1	26.5
Canada	22.8	23.8	21.7	14.2	15.9	18.5	26.7	29.6	24.3	11.6	12.3	15.5
United States	12.4	15.1	16.7	12.1	13.7	17.2	8.2	8.6	10.9	14.0	15.0	18.7
Mexico	12.8	17.0	17.4	15.0	18.3	22.4	40.5	44.9	41.8	11.7	13.3	19.8
Japan	7.8	11.0	14.6	12.5	15.0	17.2	5.9	7.4	10.0	13.5	16.8	20.1
South Korea	30.8	33.7	37.4	13.4	13.5	17.9	18.7	25.2	25.8	13.8	15.0	18.9
Taiwan	37.9	37.8	47.7	13.5	16.6	19.1	27.4	31.8	35.2	11.1	13.5	16.6
Australia	12.0	14.0	12.5	14.9	16.3	20.9	10.7	11.0	11.5	16.4	18.9	23.7
Brazil	6.4	9.0	9.5	14.7	16.4	19.1	7.1	10.5	10.2	17.5	18.5	22.3
China	14.7	16.5	23.8	17.1	19.2	21.6	14.4	15.5	22.3	16.5	20.8	23.8
Indonesia	10.4	13.0	13.2	16.1	14.8	18.0	26.6	29.4	24.7	16.4	16.3	22.7
India	5.2	8.1	10.8	13.7	13.6	18.7	14.5	18.2	21.7	18.0	18.8	26.0
Russia	4.9	6.2	4.1	18.2	19.6	23.3	12.8	15.2	11.9	21.4	22.2	23.7
Rest of World	12.4	11.1	16.5	14.0	11.6	14.3	36.5	29.8	36.5	11.6	10.3	11.4

Source: WIOD database, Version January 2011; author's calculations

4.3.2 ICT and Non-ICT capital

Now we move on to split up the capital component into ICT and Non-ICT capital and later on also labor into its subcomponents.[13] Table 7 presents the results for the two capital categories.

First, one has to note that trade and trade balances in ICT capital are generally lower than for Non-ICT capital. In most cases, surplus countries are net exporters of both types of capital. Particularly, the US also shows a worsening trade deficit in the value of ICT capital whereas China shows a rising surplus. More generally, some advanced countries which would have been expected to be net exporters of ICT capital turn out to show a negative balance and vice versa for the less developed countries. Thus this deserves some more detailed explanations with respect to trade structures, factor rewards, and so on.

4.3.3 Educational attainment categories

Finally, we present in Table 8 the results when splitting up trade flows in labor terms into the components high-educated and medium and low educated.

With respect to high educated labor the pattern is mostly as expected: the more advanced countries and those better endowed with skilled labor are also net exporters of it. This is the case for most of the EU-15 countries, the notable exceptions are Austria and Italy whereas other countries with deficits like Greece, Portugal and Spain are less well endowed with skilled labor. Also the US is showing a trade surplus with respect to skilled labor which is however slightly declining over time. The other two countries (Canada and Mexico) run larger deficits. The Asian countries also show surpluses with respect to skilled labor which are rising in all cases. All the other have experienced deficits; particularly, China shows a rising deficit in the trade of skilled labor. Regarding medium educated employment, most of the EU-15 countries show trade surpluses as expected with the exceptions of Greece, Spain and Portugal. These surpluses are rather high and/or increasing in Austria, Germany, Netherlands, Sweden and the UK. Also the Eastern European countries show in a number of cases a surplus in this category with the exceptions of Bulgaria and Romania. Significant and rising surpluses are found in the Czech Republic, Poland and Slovenia. The US started with a surplus in this category of medium skilled workers but was switching to a deficit in 2000 which was then further increasing. Canada is running a surplus whereas Mexico shows a deteriorating deficit. Again the Asian countries show increasing surpluses which is however rather small in the case of Taiwan. Within the group of the remaining countries all

[13] Data for ICT shares in capital income are preliminary and based on imputed values for some countries; thus results will be revised and to be interpreted cautiously.

Table 7 Net trade in ICT and Non-ICT capital (total trade), in bn US-$

	ICT capital			Non-ICT capital		
Reporter	1995	2000	2005	1995	2000	2005
Austria	-1.1	-0.8	-1.2	-5.6	-1.2	-1.3
Belgium	1.3	0.6	1.1	0.8	-3.6	-3.8
Denmark	0.6	0.2	-0.4	-0.4	1.6	-0.1
Finland	-0.1	0.6	-0.3	2.8	4.0	0.3
France	-3.2	-0.9	-5.9	-21.6	-26.0	-63.9
Germany	-5.2	-5.2	-7.9	-42.8	-51.0	-13.2
Greece	-0.9	-0.8	-0.7	-6.7	-8.8	-14.7
Ireland	-0.3	-0.3	-1.8	5.8	14.5	27.0
Italy	-2.9	-4.4	-9.0	-3.7	-12.3	-38.4
Luxembourg	0.3	0.4	0.6	1.8	1.5	2.2
Netherlands	-0.5	-0.7	-2.2	3.6	-1.0	3.8
Portugal	-0.4	-0.8	-1.0	-4.4	-7.2	-11.2
Spain	-1.1	-2.4	-7.3	-8.5	-19.8	-39.3
Sweden	1.5	1.7	2.7	3.3	-0.7	-1.2
United Kingdom	0.0	-0.5	-5.6	-19.3	-49.5	-86.2
Bulgaria	-0.0	-0.1	-0.2	-0.2	-0.5	-2.1
Cyprus	-0.0	-0.0	-0.1	-0.1	-0.2	-0.5
Czech Republic	-0.4	-0.3	-1.0	-0.2	-0.5	0.6
Estonia	-0.0	-0.0	-0.1	-0.1	-0.3	-0.7
Hungary	0.1	-0.3	-0.9	-1.9	-1.4	-1.6
Latvia	-0.0	-0.0	-0.2	-0.2	-0.4	-1.4
Lithuania	-0.1	-0.1	-0.2	-0.5	-0.9	-2.1
Malta	-0.0	-0.0	0.0	-0.1	-0.1	-0.1
Poland	1.0	0.4	2.4	-0.3	-4.7	-0.2
Romania	-0.2	-0.2	-0.6	-1.7	-1.9	-6.6
Slovak Republic	0.5	-0.1	-0.3	0.2	0.0	-0.6
Slovenia	0.1	0.0	-0.0	-1.2	-0.7	-0.8
Turkey	-0.6	-1.5	-3.3	-6.2	-11.9	-24.7
Canada	-1.5	-1.0	-4.7	15.9	33.4	37.2
United States	-2.7	-24.1	-56.9	-122.5	-282.6	-397.3
Mexico	1.9	3.5	7.7	20.5	28.8	32.8
Japan	0.8	3.4	-5.0	11.2	-3.9	2.5
South Korea	-2.9	-2.4	-2.8	-7.2	3.8	0.7
Taiwan	-1.8	-2.5	-2.0	-1.4	3.7	1.5
Australia	-0.6	-1.2	-3.6	1.0	1.5	4.6
Brazil	0.1	-0.0	3.5	-0.4	0.2	18.2
China	2.7	4.7	41.5	13.4	22.0	58.4
Indonesia	1.4	1.6	3.3	12.1	19.7	21.5
India	0.7	2.3	8.2	11.2	15.6	22.6
Russia	3.1	5.2	14.3	25.9	44.4	97.2
Rest of World	10.5	25.7	39.7	127.9	296.2	380.8

Source: WIOD database, Version January 2011; author's calculations

Table 8 Net trade in labor by educational categories, in bn US-$

	High educated			Medium educated			Low educated		
Reporter	1995	2000	2005	1995	2000	2005	1995	2000	2005
Austria	-4.4	-4.3	-5.9	6.2	7.0	15.0	-4.4	-2.9	-4.8
Belgium	1.3	1.0	2.6	-0.5	4.0	12.3	9.2	5.1	2.2
Denmark	-0.1	-0.0	-1.1	4.5	5.5	9.4	0.2	-0.1	0.3
Finland	-0.6	-0.1	0.3	4.0	4.4	6.5	2.7	1.5	0.0
France	-0.1	1.6	3.7	19.2	17.9	32.6	12.4	2.7	-2.9
Germany	3.4	0.4	26.8	121.9	114.4	200.2	-36.8	-27.7	-29.9
Greece	-2.5	-4.2	-7.0	-6.8	-8.2	-13.1	-2.7	-3.6	-7.0
Ireland	-0.5	-2.6	-3.1	0.1	-0.4	-0.5	2.0	1.0	2.0
Italy	-10.8	-10.5	-20.6	-10.4	-4.4	12.2	51.5	24.8	32.0
Luxembourg	0.1	0.0	1.6	0.0	0.7	1.0	0.9	0.0	0.5
Netherlands	-4.2	0.8	16.9	8.8	7.4	14.5	13.4	11.7	12.3
Portugal	-2.2	-3.1	-4.4	-6.3	-7.4	-9.8	2.8	2.7	4.0
Spain	-3.2	-3.9	-10.6	-19.1	-23.7	-39.4	10.6	6.5	1.4
Sweden	-0.8	-2.0	-0.6	8.1	13.5	21.6	2.9	1.7	1.1
United Kingdom	2.9	17.8	17.0	15.9	22.3	30.4	-5.9	-16.6	-25.8
Bulgaria	0.0	-0.2	-0.7	-0.6	-0.9	-2.6	1.2	1.4	1.9
Cyprus	0.1	0.0	-0.1	-0.0	0.0	-0.2	0.0	0.0	-0.1
Czech Republic	-0.6	-1.3	-1.5	0.0	1.2	7.4	-2.3	-2.3	-4.3
Estonia	0.1	0.2	0.3	0.1	0.5	0.6	-0.2	-0.2	-0.5
Hungary	0.3	0.0	1.2	-0.1	-0.9	0.2	-1.0	-1.5	-2.6
Latvia	0.1	0.1	-0.2	0.1	0.1	-0.2	-0.1	-0.2	-0.6
Lithuania	0.1	0.1	0.2	0.1	0.5	0.8	-0.3	-0.4	-1.0
Malta	-0.0	-0.0	-0.0	-0.2	-0.2	-0.2	0.1	0.2	0.2
Poland	-0.3	-2.5	-1.4	3.5	-0.3	3.5	-2.3	-4.7	-8.1
Romania	-0.3	-0.5	-1.6	-2.3	-2.2	-6.8	1.9	2.5	5.0
Slovak Republic	-0.2	-0.4	-1.0	-0.3	0.1	0.6	-0.8	-1.0	-2.3
Slovenia	0.0	-0.0	-0.1	1.8	1.0	2.5	-0.4	-0.4	-0.8
Turkey	-1.7	-3.4	-5.3	-7.4	-10.1	-16.3	6.7	9.4	16.4
Canada	-9.9	-13.0	-17.3	22.5	31.7	43.4	-10.8	-12.4	-19.3
United States	69.9	72.1	51.5	4.3	-52.2	-140.8	-82.1	-129.9	-177.9
Mexico	-8.0	-21.9	-23.3	-15.8	-36.2	-37.1	6.6	14.5	13.1
Japan	23.6	33.7	45.4	64.3	74.7	83.3	-10.0	-22.7	-40.3
South Korea	9.4	15.8	35.5	4.2	10.4	15.0	1.7	-2.7	-11.1
Taiwan	7.4	11.4	25.3	1.9	2.0	3.3	1.3	-1.9	-5.5
Australia	-2.0	-0.9	-4.6	-5.1	-2.8	-7.6	7.7	8.4	7.4
Brazil	-2.1	-4.7	-1.1	-11.2	-11.2	-8.8	6.7	9.6	24.1
China	-7.6	-12.2	-34.5	10.5	23.7	79.8	16.0	23.6	71.8
Indonesia	-3.7	-2.9	-3.9	-12.4	-6.6	-10.8	3.6	5.5	8.0
India	-1.9	-2.6	-5.4	-6.8	-7.0	-15.6	0.9	2.2	2.6
Russia	-1.6	0.1	1.0	-12.4	-6.3	-18.2	5.8	12.6	21.3
Rest of World	-49.1	-58.0	-73.9	-184.3	-162.0	-268.4	-8.7	83.6	117.1

Source: WIOD database, Version January 2011; author's calculations

with the exception of China show deficits which are increasing for Australia, India and Russia. Finally, with respect to low educated employment the evidence for the EU-15 is somewhat mixed with deficits showing up in Austria, Germany, Greece and the UK and surpluses in Belgium, Finland, France Italy, Netherlands and Spain though in most cases these are decreasing. IN case of the Eastern European countries the evidence is rather mixed again with surpluses found in Bulgaria, Romania and also Turkey which might be expected and deficits in the Czech Republic, Hungary, Poland, the Slovak Republic and Slovenia. Canada and the US show deficits which was particularly increasing for the latter. Mexico has a surplus over the whole period in this category. With respect to Asian countries all show a deficit in low educated labor in 2005. South Korea and Taiwan have switched from a surplus to a deficit over the period considered. Finally, the remaining countries all show surpluses which are particularly in increasing in Brazil, China, and Russia.

4.4 Evolution of trade balances

These patterns and changes over time with respect to trade balances in factors can better be understand when looking at all factors simultaneously. We therefore show in Table 9 again these numbers for 1995 and 2005. Again let us highlight some important countries (numbers are in bn US-$). The total trade deficit in the US declined from -133.2 to -721.5. In absolute terms, particularly strong declines occurred in non-ICT capital (-275) and medium educated labor (-145). In relative terms, also the decline in ICT capital is rather strong. Only in terms of high educated labor the US is still running a surplus which also declined slightly however (from 70 to 52). Looking at China which shows a increase of its trade surplus from 35 to 217 the increase if somewhat more evenly distributed with medium and low educated labor accounting for 70 and 56 respectively; but also ICT and non-ICT capital increased by 40 and 45 respectively. China is however still running a deficit in high educated labor which even deteriorated (from -7.6 to -34.5). Germany also shows a strong increase in its surplus (from 40.5 to 176) with a strong increase in medium educated labor (78.3) but also in high educated labor and non-ICT capital (23 and 29.6, respectively). Trade deficits in the other categories declined in case of low educated labor but increased in terms of ICT capital. Finally, let us consider Japan which shows a rather stable trade surplus. Whereas the deficits in low educated labor declined (-30) the surpluses in high and medium educated labor increased (22 and 19, respectively). With respect to capital categories the balance worsened and became even negative in terms of ICT capital whereas still positive with respect to non-ICT capital.[14]

[14]Results for ICT and Non-ICT split are based on preliminary data.

Table 9 Trade balances, in bn US-$

			Capital						Labor			
	Total		ICT		Non-ICT		High		Medium		Low	
Reporter	1995	2005	1995	2005	1995	2005	1995	2005	1995	2005	1995	2005
Austria	-9.3	1.9	-1.1	-1.2	-5.6	-1.3	-4.4	-5.9	6.2	15.0	-4.4	-4.8
Belgium	12.0	14.4	1.3	1.1	0.8	-3.8	1.3	2.6	-0.5	12.3	9.2	2.2
Denmark	4.8	8.1	0.6	-0.4	-0.4	-0.1	-0.1	-1.1	4.5	9.4	0.2	0.3
Finland	8.7	6.9	-0.1	-0.3	2.8	0.3	-0.6	0.3	4.0	6.5	2.7	0.0
France	6.7	-36.4	-3.2	-5.9	-21.6	-63.9	-0.1	3.7	19.2	32.6	12.4	-2.9
Germany	40.5	176.0	-5.2	-7.9	-42.8	-13.2	3.4	26.8	121.9	200.2	-36.8	-29.9
Greece	-19.7	-42.5	-0.9	-0.7	-6.7	-14.7	-2.5	-7.0	-6.8	-13.1	-2.7	-7.0
Ireland	7.1	23.4	-0.3	-1.8	5.8	27.0	-0.5	-3.1	0.1	-0.5	2.0	2.0
Italy	23.8	-23.8	-2.9	-9.0	-3.7	-38.4	-10.8	-20.6	-10.4	12.2	51.5	32.0
Luxembourg	3.1	5.9	0.3	0.6	1.8	2.2	0.1	1.6	0.0	1.0	0.9	0.5
Netherlands	21.1	45.2	-0.5	-2.2	3.6	3.8	-4.2	16.9	8.8	14.5	13.4	12.3
Portugal	-10.5	-22.5	-0.4	-1.0	-4.4	-11.2	-2.2	-4.4	-6.3	-9.8	2.8	4.0
Spain	-21.3	-95.3	-1.1	-7.3	-8.5	-39.3	-3.2	-10.6	-19.1	-39.4	10.6	1.4
Sweden	15.0	23.6	1.5	2.7	3.3	-1.2	-0.8	-0.6	8.1	21.6	2.9	1.1
United Kingdom	-6.5	-70.2	0.0	-5.6	-19.3	-86.2	2.9	17.0	15.9	30.4	-5.9	-25.8
Bulgaria	0.4	-3.7	-0.0	-0.2	-0.2	-2.1	0.0	-0.7	-0.6	-2.6	1.2	1.9
Cyprus	-0.1	-1.0	-0.0	-0.1	-0.1	-0.5	0.1	-0.1	-0.0	-0.2	0.0	-0.1
Czech Republic	-3.5	1.3	-0.4	-1.0	-0.2	0.6	-0.6	-1.5	0.0	7.4	-2.3	-4.3
Estonia	-0.0	-0.5	-0.0	-0.1	-0.1	-0.7	0.1	0.3	0.1	0.6	-0.2	-0.5
Hungary	-2.6	-3.8	0.1	-0.9	-1.9	-1.6	0.3	1.2	-0.1	0.2	-1.0	-2.6
Latvia	-0.2	-2.5	-0.0	-0.2	-0.2	-1.4	0.1	-0.2	0.1	-0.2	-0.1	-0.6
Lithuania	-0.8	-2.2	-0.1	-0.2	-0.5	-2.1	0.1	0.2	0.1	0.8	-0.3	-1.0
Malta	-0.2	-0.2	-0.0	0.0	-0.1	-0.1	-0.0	-0.0	-0.2	-0.2	0.1	0.2
Poland	1.7	-3.7	1.0	2.4	-0.3	-0.2	-0.3	-1.4	3.5	3.5	-2.3	-8.1
Romania	-2.5	-10.5	-0.2	-0.6	-1.7	-6.6	-0.3	-1.6	-2.3	-6.8	1.9	5.0
Slovak Republic	-0.7	-3.6	0.5	-0.3	0.2	-0.6	-0.2	-1.0	-0.3	0.6	-0.8	-2.3
Slovenia	0.2	0.9	0.1	-0.0	-1.2	-0.8	0.0	-0.1	1.8	2.5	-0.4	-0.8
Turkey	-9.3	-33.2	-0.6	-3.3	-6.2	-24.7	-1.7	-5.3	-7.4	-16.3	6.7	16.4
Canada	16.2	39.3	-1.5	-4.7	15.9	37.2	-9.9	-17.3	22.5	43.4	-10.8	-19.3
United States	-133.2	-721.5	-2.7	-56.9	-122.5	-397.3	69.9	51.5	4.3	-140.8	-82.1	-177.9
Mexico	5.2	-6.7	1.9	7.7	20.5	32.8	-8.0	-23.3	-15.8	-37.1	6.6	13.1
Japan	89.8	86.0	0.8	-5.0	11.2	2.5	23.6	45.4	64.3	83.3	-10.0	-40.3
South Korea	6.0	38.7	-2.9	-2.8	-7.2	0.7	9.4	35.5	4.2	15.0	1.7	-11.1
Taiwan	8.1	22.4	-1.8	-2.0	-1.4	1.5	7.4	25.3	1.9	3.3	1.3	-5.5
Australia	1.0	-3.8	-0.6	-3.6	1.0	4.6	-2.0	-4.6	-5.1	-7.6	7.7	7.4
Brazil	-6.9	35.8	0.1	3.5	-0.4	18.2	-2.1	-1.1	-11.2	-8.8	6.7	24.1
China	34.9	217.1	2.7	41.5	13.4	58.4	-7.6	-34.5	10.5	79.8	16.0	71.8
Indonesia	1.0	18.1	1.4	3.3	12.1	21.5	-3.7	-3.9	-12.4	-10.8	3.6	8.0
India	4.0	12.3	0.7	8.2	11.2	22.6	-1.9	-5.4	-6.8	-15.6	0.9	2.6
Russia	20.9	115.6	3.1	14.3	25.9	97.2	-1.6	1.0	-12.4	-18.2	5.8	21.3
Rest of World	-104.8	194.5	10.5	39.7	127.9	380.8	-49.1	-73.9	-184.3	-268.4	-8.7	117.1

Source: WIOD database, Version January 2011; author's calculations

5 Conclusions

In this paper we introduce and apply a method for measuring trade in value added and its subcomponents based on recent approaches as applied in the literature on measuring and testing the factor content of trade when taking into account trade in intermediates. This allows to take account of a country being an exporter and importer of intermediates simultaneously and the fact of considerable two-way trade in intermediates. The supposed framework allows to split trade in value added into various forms of domestic and foreign content of exports and imports which also links to recent measures of vertical specialization in production networks. Overall, all this components sum up to a country's overall trade deficit or surplus. Based on this approach we are also able to show in a straightforward manner that a country's trade balance in gross terms equals its trade balance in value added terms which links it to national accounting identities. To our knowledge this has not yet been shown in a general way. Finally, the link of net gross and value added trade allows to analyze in which factors - as components of value added trade - a country is a net exporter or net importer. Thus, this shifts the focus of trade in goods (maybe differentiated by industries or types of products, e.g. by technology content) to net trade in factors.

Though the paper is rather descriptive it shows a quite important aspect of the patterns of trade in value added and factors providing further insights additional to the existing literature. This paper also points towards further directions of research which will include an more detailed analysis of the bilateral structures of trade in factors and a thorough discussion of the underlying factors which will include technology and endowment differences, differences in factor rewards and trade structures and the respective changes over time. For the latter it will be important to better differentiate between traded intermediates into raw materials, components and more generally the role of non-competing imports for some countries. In this respect also deflated time series will become important. Based on this approach and the data available in the WIOD project such factors can be studied in future research in more detail.

A Tables

Table 10 List of WIOD countries

ISO code	Description
AUS	Australia
AUT	Austria
BEL	Belgium
BGR	Bulgaria
BRA	Brazil
CAN	Canada
CHN	China
CYP	Cyprus
CZE	Czech Republic
DEU	Germany
DNK	Denmark
ESP	Spain
EST	Estonia
FIN	Finland
FRA	France
GBR	Great Britain
GRC	Greece
HUN	Hungary
IDN	Indonesia
IND	India
IRL	Ireland
ITA	Italy
JPN	Japan
KOR	Korea
LTU	Lithuania
LUX	Luxembourg
LVA	Latvia
MEX	Mexico
MLT	Malta
NLD	Netherlands
POL	Poland
PRT	Portugal
ROM	Romania
RUS	Russia
SVK	Slovak Republic
SVN	Slovenia
SWE	Sweden
TUR	Turkey
TWN	Tawain
USA	USA

Table 11 List of WIOD industries

NACE code	Description
AtB	Agriculture, Hunting, Forestry and Fishing
C	Mining and Quarrying
15t16	Food, Beverages and Tobacco
17t18	Textiles and Textile Products
19	Leather, Leather and Footwear
20	Wood and Products of Wood and Cork
21t22	Pulp, Paper, Paper , Printing and Publishing
23	Coke, Refined Petroleum and Nuclear Fuel
24	Chemicals and Chemical Products
25	Rubber and Plastics
26	Other Non-Metallic Mineral
27t28	Basic Metals and Fabricated Metal
29	Machinery, n.e.c.
30t33	Electrical and Optical Equipment
34t35	Transport Equipment
36t37	Manufacturing, n.e.c.; Recycling
E	Electricity, Gas and Water Supply
F	Construction
50	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel
51	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles
52	Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods
H	Hotels and Restaurants
60	Inland Transport
61	Water Transport
62	Air Transport
63	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies
64	Post and Telecommunications
J	Financial Intermediation
70	Real Estate Activities
71t74	Renting of Machinery and Equipment; Other Business Activities
L	Public Admin and Defence; Compulsory Social Security
M	Education
N	Health and Social Work
O	Other Community, Social and Personal Services
P	Private Households with Employed Persons

Table 12 List of WIOD products (CPA 1-37)

CPA code	Description
1	Products of agriculture, hunting and related services
2	Products of forestry, logging and related services
5	Fish and other fishing products; services incidental of fishing
10	Coal and lignite; peat
11	Crude petroleum and natural gas; services incidental to oil and gas extraction excluding surveying
12	Uranium and thorium ores
13	Metal ores
14	Other mining and quarrying products
15	Food products and beverages
16	Tobacco products
17	Textiles
18	Wearing apparel; furs
19	Leather and leather products
20	Wood and products of wood and cork (except furniture); articles of straw and plaiting materials
21	Pulp, paper and paper products
22	Printed matter and recorded media
23	Coke, refined petroleum products and nuclear fuels
24	Chemicals, chemical products and man-made fibres
25	Rubber and plastic products
26	Other non-metallic mineral products
27	Basic metals
28	Fabricated metal products, except machinery and equipment
29	Machinery and equipment n.e.c.
30	Office machinery and computers
31	Electrical machinery and apparatus n.e.c.
32	Radio, television and communication equipment and apparatus
33	Medical, precision and optical instruments, watches and clocks
34	Motor vehicles, trailers and semi-trailers
35	Other transport equipment
36	Furniture; other manufactured goods n.e.c.
37	Secondary raw materials
40	Electrical energy, gas, steam and hot water
41	Collected and purified water, distribution services of water
45	Construction work
50	Trade, maintenance and repair services of motor vehicles and motorcycles; retail sale of automotive fuel
51	Wholesale trade and commission trade services, except of motor vehicles and motorcycles
52	Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods
55	Hotel and restaurant services
60	Land transport; transport via pipeline services
61	Water transport services
62	Air transport services
63	Supporting and auxiliary transport services; travel agency services
64	Post and telecommunication services
65	Financial intermediation services, except insurance and pension funding services
66	Insurance and pension funding services, except compulsory social security services
67	Services auxiliary to financial intermediation
70	Real estate services
71	Renting services of machinery and equipment without operator and of personal and household goods
72	Computer and related services
73	Research and development services
74	Other business services
75	Public administration and defence services; compulsory social security services
80	Education services
85	Health and social work services
90	Sewage and refuse disposal services, sanitation and similar services
91	Membership organization services n.e.c.
92	Recreational, cultural and sporting services
93	Other services
95	Private households with employed persons

References

Ali-Yrkkoö, J. (2010). *Nokia and Finland in a Sea of Change*. Taloustieto Oy.

Baldwin, R. (2009). Integration of the North American economy and the new paradigm globalisation. *CEPR Discussion Paper Series 7523*.

Baldwin, R. and F. Robert-Nicoud (2010). Trade-in-goods and trade-in-tasks: An integrating framework. *NBER Working Paper 15882*.

Baldwin, R. E. (2008). *The Development and Testing of Hecksher-Ohlin Trade Models*. MIT Press.

Böhm-Bawerk, E. v. (1888). *The Positive Theory of Capital*. London: Macmillan and Co.

Chen, H., M. Kondratowicz, and K.-M. Yi (2005). Vertical specialization and three facts about U.S. international trade. *North American Journal of Economics and Finance 16*, 35–59.

Daudin, G., C. Rifflart, and D. Schweisguth (2009). Who produces for whom in the world economy? *OFCE Document de Travail 18*.

Davis, D. R. and D. Weinstein (2001). An account of global factor trade. *American Economic Review 91*(5), 1423–1453.

Deardorff, A. V. (1982). The general validity of the Heckscher-Ohlin theorem. *American Economic Review 72*(4), 197–209.

Erumban, A. A., R. F. Gouma, J. d. V. Gaaitzen, and M. P. Timmer (2011). Socio-Economic accounts for the World Input-Output Database. Technical report, GGDC research memorandum, in preparation.

Escaith, H. (2008). Measuring trade in value added in the new industrial economy: Statistical implications. *MPRA Working Paper 14454*.

Eurostat (2008). *Eurostat Manual of Supply, Use and Input-Output Tables*. European Commission, Brussels.

Faust, M., U. Voskamp, and V. Wittke (2004). *European Industrial Restructuring in a Gobal Economy: Fragmentation and Relocation of Value Chains*.

Foster, N. and R. Stehrer (2011). Biltateral patterns of net trade in value added and factors. *mimeo*.

Francois, J. and O. Pindyuk (2010). Consolidated data on international trade in services. Technical report, Document underlying Deliverable 2.3, WIOD project.

Grossman, G. M. and E. Rossi-Hansberg (2008). Task trade between similar countries. *NBER Working Paper 14554*.

Hiratsuka, D. and Y. Uchida (Eds.) (2010). *Input Trade and Production Networks in East Asia*. Edward Elgar.

Hummels, D., J. Ishii, and K.-M. Yi (2001). The nature and growth of vertical specialisation in world trade. *Journal of International Economics 54*, 75–96.

Johnson, R. C. and G. Noguera (2009). Acconting for intermediates: Production sharing and trade in value added. *forthcoming*.

Koopman, R., W. Powers, and Z. Wang (2010). Give credit where credit is due: Tracing value added in global production chains. *NBER Working Paper*.

Kraemer, K. and J. Dedrick (2002). Dell computer: Organization of a global production network. *Unpublished manuscript, Personal Computing Industry Center, UC Irvine*.

Krueger, A. (1999). Measuring labor's share. *American Economic Review, Papers and Proceedings 89*(2), 45–51.

Leontief, W. (1953). Domestic production and foreign trade: The American capital position revisited. *Proceeding of the American Philosophical Society 97*, 332–349.

Linden, G., K. Kraemer, and J. Dedrick (2009). Who captures value in a global innovation system? The case of Apple's iPod. *Communications of the ACM 52*(3), 140–144.

MacKechnie, G. (2008). Understanding shifting patterns of outsourcing - Integrating macro and micro analysis. *Unpublished Manuscript*.

Maurer, A. and C. Degain (2010). Globalization and trade flows: What you see is not what you get! *WTO Staff Working Paper ERSD-2010-12*.

Meng, B. and S. Inomata (2009). Production networks and spatial economic interdependence: An international input-output analysis of the Asia-Pacific region. *IDE Discussion Paper 185.2009.3*.

Meng, B. and N. Yamano (2010). Alternative measurements of vertical specialisation by input-output database. *Unpublished manuscript*.

Meng, B., N. Yamano, and C. Webb (2011). Application of factor decomposition techniques to vertical specialisation measurement. *IDE Discussion Paper 276*.

Miroudot, S., R. Lanz, and A. Ragoussis (2009). Trade in intermediate goods and services. *TAD/TC/WP(2009)1, OECD, Paris*.

Pöschl, J. and R. Stehrer (2010). WIOD international trade in goods data. Data sources, construction issues and next steps. Technical report, Deliverable 2.2, WIOD project.

Reimer, J. (2006). Global production sharing and trade in services of factors. *Journal of International Economics 68*, 384–408.

Samuelson, P. (1966). A summing up. *The Quarterly Journal of Economics 80*(4), 568–583.

Staiger, R. W. (1986). Measurement of the factor content of trade with traded intermediate goods. *Journal of International Economics 21*, 361–368.

Stehrer, R., J. Ali-Yrkkö, D. Hanzl, N. Foster, P. Rouvinen, T. Seppälä, R. Stöllinger, and P. Ylä-Anttila (2010). Trade in intermediate products and EU manufacturing supply chains. *Background Report to the Competetiveness Report 2010*.

Stehrer, R., J. Ali-Yrkkoö, D. Hanzl-Weiss, N. Foster, P. Rouvinen, T. Seppälä, R. Stöllinger, and P. Ylä-Anttila (2011). *Trade in Intermediate Products and EU manufacturing Supply Chains*. Number 369 in wiiw Working Paper. The Vienna Institute for International Economic Studies.

Tempest, R. (1996). Barbie and the world economy. *Los Angeles Times September 22*.

Temurshoev, U. and M. P. Timmer (2011). Joint estimation of supply and use tables. *Papers in Regional Science , forthcoming*.

Timmer, M., B. Los, R. Stehrer, and G. d. Vries (2011). Making room for China: A global value chain approach. *Unpublished Manuscript*.

Timmer, M., T. V. Moergastel, E. Stuivenwold, G. Ypma, M. OMahony, and M. Kangasniemi (2007). EU KLEMS growth and productivity accounts. Technical report, March, available at http://www.euklems.net.

Trefler, D. (1993). International factor price differences: Leontief was right! *Journal of Political Economy 101*(6), 961–987.

Trefler, D. and S. Zhu (2010). The structure of factor content predictions. *The Journal of International Economics 82*, 195–207.

Vanek, J. (1968, November). The factor proportions theory: The N-factor case. *Kyklos 21*(4), 749–756.

Varian, H. (2007). An iPod has global value. Ask the (many) countries that make it. *The New York Times June 28*.

Xing, Y. and N. Detert (2010). How iPhones widens the US trade deficits with prc. *GRIPS Discussion Paper 10-21*.

Yamano, N., B. Meng, and K. Fukasaku (2010). Fragmentation and changes in the Asian trade network. *ERIA Research Brief*.