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Abstract

Measuring Trade in Value Added, and Beyond

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The increasing international fragmentation of production that has occurred in recent decades driven by technological progress, cost, access to resources and markets, trade policy reforms, and indeed emerging economies, has challenged our conventional wisdom on how we look at and interpret trade. Traditional measures of trade, record gross flows of goods and services each and every time they cross borders leading to what many describe as a 'multiple' counting of trade, which may lead to misguided policy measures. To respond to this challenge a number of initiatives have been launched in recent years that attempt to measure, or perhaps more accurately 'estimate', what has become known as 'trade in value-added'. These have all helped to shed light on the importance of accounting for global value chains and have helped raise awareness of a growing need to mainstream the production of these estimates within the international statistics system. Responding to these challenges on 15 March 2012 the OECD and WTO undertook to collaborate on the development of estimates of trade in value-added, resulting in a first release of a preliminary database on 16 January 2013. This paper describes some of the key results of that work, and the methodology used. It also describes the detailed assumptions behind the methodology to necessarily deal with the treatment of data, and also the initiatives launched to improve the quality of those assumptions and the underlying data. The paper also describes extensions of the work to consider trade in jobs, and what has been described as 'trade in income, as well as the data issues relevant to both strands of work. Trade in value-added estimates have been able to shed important light on our understanding of international trade and its relation to activity and competitiveness, in particular the importance of recognising the importance of imports to exports, and, so, the hitherto hidden costs of protectionism as well as the benefits of trade liberalisation, particularly in services. But, with significant shares of exports being driven by foreign affiliates, they have also revealed the importance of going beyond just value-added towards income, in order to capture flows outside of conventional international trade statistics, such as the repatriation of profits related to the use of knowledge based assets (brands, R&D, etc).

MEASURING TRADE IN VALUE-ADDED AND BEYOND

1. Introduction

Global value chains (GVCs) have become a dominant feature of today's global economy. This growing process of international fragmentation of production, driven by technological progress, cost, access to resources and markets, and trade policy reforms, has challenged our conventional wisdom on how we look at and interpret trade and, in particular, the policies that we develop around it. Indeed traditional measures of trade, that record gross flows of goods and services each and every time they cross borders, alone, may lead to misguided decisions being taken.

In practice, two main approaches (micro and macro) have been used to shed light on this issue. The former is perhaps best characterised by the well known Apple iPod example (Dedrick *et al*, 2010), which showed that of the $144 (Chinese) factory-gate price of an iPod, less than 10% contributed to Chinese value added, with the bulk of the components (about $100) being imported from Japan and much of the rest coming from the US and Korea.

But this stylised approach can generally only be conducted for specific products and, even then, only reveals part of the story related to who benefits from trade and how global value chains work; as it is typically unable to reveal how the intermediate parts are created. For example the message would be significantly different if, for sake of argument, the imported parts from Japan used to make the iPod required significant Chinese content. To deal with the bigger picture and also to capture all of the upstream effects, a number of studies have adopted a macro approach, based on the construction of inter-country or world input-output tables (Hummels *et al*. (2001), Daudin *et al*. (2006, 2009), Johnson and Noguera (2010) and Koopman *et al.* (2011)). And a number of pioneering initiatives, such as those of GTAP, the WTO with IDE-JETRO and also the WIOD (World Input-Output Database), have helped accelerate improvements in the underlying statistics used to construct the results.

But these studies and initiatives have generally been one-off in nature and often require the use of non-official statistical data. What has been lacking thus far has been a systematic attempt to mainstream the development of statistics in this area. In response to this need, on 15 March 2012, the OECD and WTO joined forces to develop a database of Trade in Value-Added (TiVA) indicators and to mainstream their production within the international statistics system. The first preliminary results from this intiative were released on 16 January 2013 and some highlights from this first release are presented below. But, as described below further work is needed (and can be done) in order to improve the quality of the estimates produced under the ' trade in value-added' umbrella.

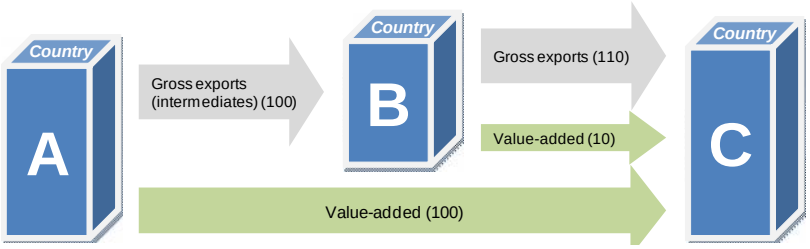
Ultimately the paper acts, in some ways, as a clarion call to statistics agencies that the world is increasingly interconnected and that conventional approaches used to understand how economies work can no longer rely solely on national statistics. Increasingly, in order to understand how economies work, and how to target and create industrial policies targeting competitiveness for example (not withstanding trade policies and the implications and importance of trade), it is necessary to see the whole. National statistics build pictures based on inter-relationships between producers and consumers and the rest of the world. But these relationships, particularly those with the rest of the world have become increasingly more complex, and, as such, there is an increasing need to consider global production within a global accounting framework. This implies a departure from the traditional role of international organisations as compilers of internationally comparable national statistics, such as national input-output or supply-use tables. Instead it requires that they bring together these national tables to create a global table.

The remainder of this paper describes the policy drivers and needs for such a framework, and the underlying methodology and assumptions used to estimate trade in value-added, before finalising on the

implications for statistics offices, data collection and national input-output tables in particular, before describing future longer term future avenues of research.

2. What is Trade in Value-Added?

The Trade in Value-Added initiative addresses the double counting implicit in current gross flows of trade, and instead measures flows related to the **value** that is **added** (labour compensation, other taxes on production and operating surplus, or profits) by a country in the production of any good or service that is exported.



The simple example above illustrates this. Country A exports $100 of goods, produced entirely within A, to country B that further processes them before exporting them to C where they are consumed. B adds value of $10 to the goods and so exports $110 to C. Conventional measures of trade show total global exports and imports of $210 but only $110 of value-added has been generated in their production. Conventional measures also show that C has a trade deficit of $110 with B, and no trade at all with A, despite the fact that A is the chief beneficiary of C's consumption.

If instead we track flows in value-added, one can recalculate C's trade deficit with B on the basis of the value-added it "purchases" from B as final demand, which reduces its deficit on this basis, to $10, and apply the same approach to A's value-added to show C running a deficit of $100 with A. Note that C's overall trade deficit with the world remains at $110. All that has changed is its bilateral positions. This simple illustration reveals how output in one country can be affected by consumers in another and by how much (for example C's consumers driving A's output) but it can also reveal many other important insights into global value-chains. For example it shows that B's exports depend significantly on intermediate imports from A, and so reveals that protectionist measures on imports from A could harm its own exporters and hence competitiveness. Indeed, by providing information at the level of specific industries, it is possible to provide insights in other areas too, such as the contribution of the service sector to international trade.

3. Motivation – Why?

While the literature on trade in value-added is quite technical, it has attracted a lot of attention from policymakers. What initially seemed a concern for trade statisticians is now understood as a key issue for the policy debate. For example, Pascal Lamy, the DG of the WTO noted that "the statistical bias created by attributing commercial value to the last country of origin perverts the true economic dimension of the bilateral trade imbalances. This affects the political debate, and leads to misguided perceptions".[1] Recently, the French Senate devoted a special seminar to the related statistical and policy issues. [2]

1 . *Financial Times*, 24 January 2011.

2 WTO and Commission des Finances du Sénat, (2011) "Globalization of industrial production chains and measurement of trade in value added", Conference proceedings.

There are a number of areas where measuring trade in value-added terms brings a new perspective and is likely to impact on policies:

- **Trade, growth and competitiveness*:*** Better understanding how much domestic value-added is generated by the export of a good or service in a country is crucial for development strategies and industrial policies. Some countries have capitalised on global value chains by developing comparative advantages in specific parts of the value-chain. For example in China, much of its exports reflect assembly work, where the foreign content is high. Access to efficient imports therefore matters as much in a world of international fragmentation as does access to markets. Conventional gross trade statistics however are not able to reveal the foreign content of exports and so there is a risk that policies to protect industries where gross statistics reveal a comparative advantage may decrease the competitiveness of those very same domestic industries, and, so mercantilist-styled 'beggar thy neighbour' strategies can turn out to be 'beggar thyself' miscalculations.

- In addition domestic value-added is not only found in exports but also in imports: goods and services produced in one domestic industry are intermediates shipped abroad whose value comes back to the domestic economy embodied in the imports of other, and often the same, industries. As a consequence, tariffs, non-tariff barriers and trade measures –such as anti-dumping rights– can also impact on the competitiveness of domestic upstream producers (as well as the competitiveness of downstream producers as mentioned above) in addition to foreign producers. For example, a study of the Swedish National Board of Trade on the European shoe industry highlights that shoes "manufactured in Asia" incorporate between 50% and 80% of European Union value-added. In 2006, anti-dumping rights were introduced by the European Commission on shoes imported from China and Vietnam. An analysis in value-added terms would have revealed that EU value-added was in fact subject to the anti-dumping rights.[3]

- Looking at trade from a value-added perspective is also able to better reveal how upstream domestic industries contribute to exports, even if those same industries have little direct international exposure. Gross trade statistics for example reveal that less than one-quarter of total global trade is in services. But in value-added terms the share is significantly higher. Goods industries require significant intermediate inputs of services (both from foreign and also domestic suppliers). Looking at trade in value-added terms therefore can reveal that policies to encourage services trade liberalisation and more foreign direct investment, and so policies designed to improve access to more efficient services, can improve the export competitiveness of goods industries.

- **Global imbalances**: Accounting for trade in value-added (specifically accounting for trade in intermediate parts and components), and taking into account "trade in tasks", does not change the overall trade balance of a country with the rest of the world - it redistributes the surpluses and deficits across partner countries. When bilateral trade balances are measured in gross terms, the deficit with final goods producers (or the surplus of exporters of final products) is exaggerated because it incorporates the value of foreign inputs. The underlying imbalance is in fact with the countries who supplied inputs to the final producer. As pressure for rebalancing increases in the context of persistent deficits, there is a risk of protectionist responses that target countries at the end of global value chains on the basis of an inaccurate perception of the origin of trade

3. "Adding value to the European Economy. How anti-dumping can damage the supply of globalised European companies. Five case studies from the shoe industry", Kommerskollegium, National Board of Trade, Stockholm, 2007.

imbalances. As shown below, the preliminary results from the OECD-WTO database point to significant changes.

- **The impact of macro-economic shocks**: The 2008-2009 financial crises was characterised by a synchronised trade collapse in all economies. Authors have discussed the role of global supply chains in the transmission of what was initially a shock on demand in markets affected by a credit shortage. In particular, the literature has emphasized the "bullwhip effect" of global value chains.[4] When there is a sudden drop in demand, firms delay orders and run down inventories with the consequence that the fall in demand is amplified along the supply chain and can translate into a standstill for companies located upstream. A better understanding of value-added trade flows would provide tools for policymakers to anticipate the impact of macro-economic shocks and adopt the right policy responses. Any analysis of the impact of trade on short-term demand is likely to be biased when looking only at gross trade flows. This was again more recently demonstrated in the aftermath of the natural disaster that hit Japan in March 2011. [5]

- **Trade and employment*:*** Several studies on the impact of trade liberalisation on labour markets try to estimate the 'job content' of trade. Such analysis is only relevant if one looks at the value-added of trade. What the value-added figures can tell us is where exactly jobs are created. Decomposing the value of imports into the contribution of each economy (including the domestic one) can give an idea of who benefits from trade. The EU shoe industry example given above can be interpreted in terms of jobs. Traditional thinking in gross terms would regard imports of shoes manufactured in China and Viet Nam by EU shoe retailers as EU jobs lost and transferred to these countries. But in value-added terms, one would have to account for the EU value-added and while workers may have indeed lost their job in the EU at the assembly stage, value-added based measures would have highlighted the important contribution made by those working in the research, development, design and marketing activities that exist because of trade (and the fact that this fragmented production process keeps costs low and EU companies competitive). When comparative advantages apply to "tasks" rather than to "final products", the skill composition of labour imbedded in the domestic content of exports reflects the relative development level of participating countries. Industrialised countries tend to specialise in high skill tasks, which are better paid and capture a larger share of the total value added. A WTO and IDE-JETRO study on global value chains in East Asia shows that China specializes in low-skill types of jobs. Japan, on the contrary, has been focusing in export activities intensive in medium and high skill labour, while importing goods produced by low-skilled workers. The study also shows that the Republic of Korea was adopting a middle-of-the ground position (in 2006), but was also moving closer to the pattern found in Japan. [6]

- **Trade and the environment*:*** Another area where the measurement of trade flows in value-added terms would support policymaking is in the assessment of the environmental impact of trade. For example, concerns over greenhouse gas emissions and their potential role in climate change have triggered research on how trade openness affects CO2 emissions. The unbundling of production and consumption and the international fragmentation of production require a value-added view of trade to understand where imported goods are produced (and hence where CO2 is produced as a consequence of trade). Various OECD studies note that the relocation of industrial

4. See Escaith *et al.* (2010) and Lee *et al.* (1997).

5 See an application of international IO on "Japan's earthquake and tsunami: International trade and global supply chain impacts", VoxEU, April 2011 at http://www.voxeu.org/index.php?q=node/6430

6 See WTO and IDE-JETRO (2011).

activities can have a significant impact on differences in consumption-based and production based measures of CO2 emissions (Ahmad *et al*., 2003, Nakano *et al.*, 2009).

4. Early evidence from the OECD-WTO database[7]

At the time of writing the database is based on a global input-output table that brings together national input-output tables for 57 economies, combined with bilateral trade data on goods and services, with a breakdown into 37 industries (see below). The following provides an overview of the key messages provided by the data.

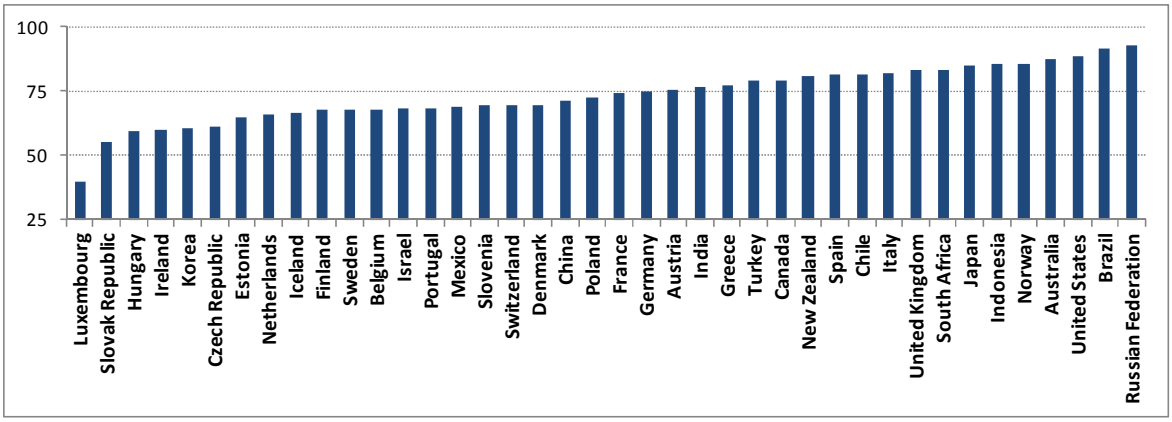
Exports require imports

The data reveals that the import content of exports (the share of value added by the export of a given product that originates abroad is significant in all countries for which data is presented (40 at the time of writing, all 34 OECD countries, Brazil, China, India, Indonesia, Russian Federation and South Africa), see Figure 1.

Typically the larger a country the lower the overall foreign content, reflecting in part scale and cost. But a number of smaller economies also have relatively low foreign content in their exports, such as Australia, Chile, and Norway, reflecting their high share of exports of natural resource goods (such as ores, oil and copper, which have not surprisingly a low foreign content). Geography also plays a role too, which helps to explain New Zealand's relatively low ratio, as well as its relatively high dependency on agricultural exports, which also have a relatively low foreign content. For mid-size economies however, particularly those in Eastern Europe, the norm is for around one-third of the value of exports to reflect foreign content.

Notwithstanding some of the interpretative caveats above, the ratio is perhaps the single most digestible indicator of the propensity of a country to engage in GVCs. It reveals the existence of European, Asian and North American production hubs and also the significant dependency many countries have on imports to generate exports. In Mexico, with its maquilladores, and China with its processors/assemblers, about one-third of overall exports reflect foreign content (and, as described below, these are considered to be conservative estimates).

Figure 1: Domestic content of Exports (Domestic Value-Added exports, % of total gross exports), 2009

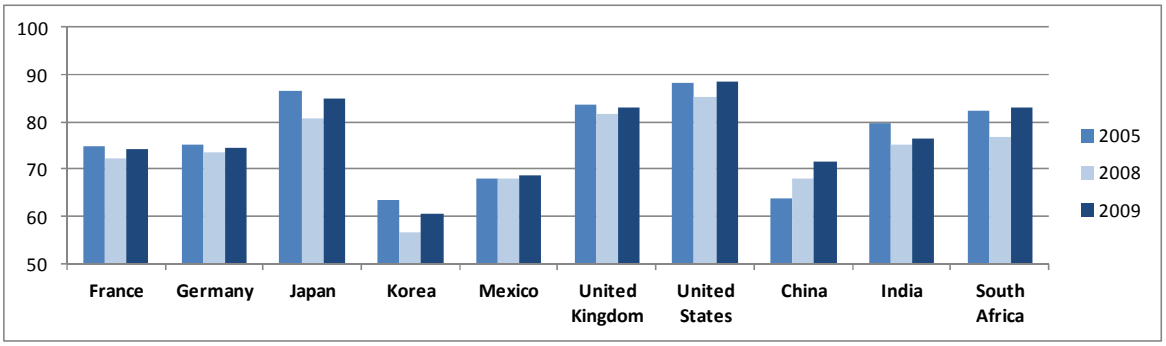


Source: OECD-WTO Trade in Value Added (TiVA) indicators, Preliminary Results, OECD January 2013

[7] For more information on the database see www.oecd.org/trade/valueadded

Some care is needed in interpreting the results however: 2009 was an exceptional year, the year that signified perhaps the nadir of the recent financial crisis, and which was partly characterised by an unprecedented slowdown in global trade. Although the database only provides data as far back as 2005, illustrative data going back to 1995 suggest that international fragmentation of production, (the import content of exports) had been steadily rising in most countries over recent decades, which continued over the period 2005-2008 (Figure 2); despite the slowdown that began to occur in many countries in 2008. But 2009 saw falls in the import content of exports, suggesting that the greater the fragmentation of a good or service, the more likely it was to be affected by the synchronised slowdown in trade. In most countries therefore, the import content of overall exports in 2009 returned to around the ratios seen in 2005 but in China the data points to a steady rise over the period, suggesting developments that saw China begin to move up the value-added chain.

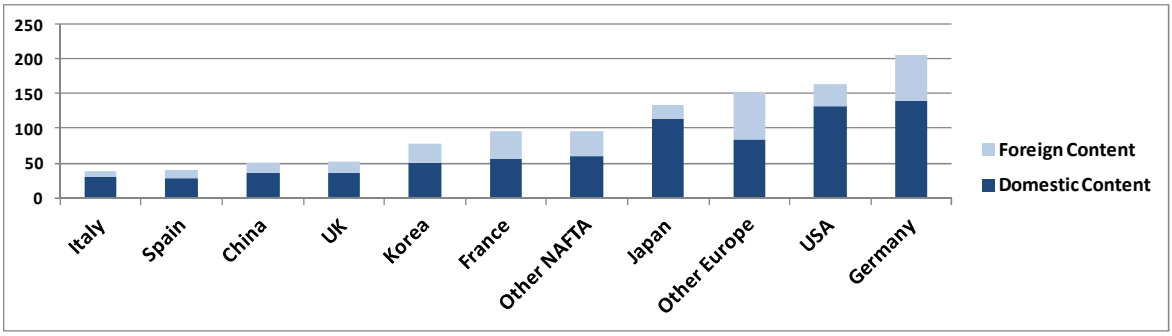
Figure 2: Domestic content of Exports (Domestic Value-Added exports, % of total gross exports), 2005-09



Source: OECD-WTO Trade in Value Added (TiVA) indicators, Preliminary Results, OECD January 2013

Tangible evidence of the scale of global value chains emerges more clearly when considering specific sectors. For example between one-third to half of the total value of exports of transport parts and equipment by most major producers originated abroad in 2009 (Figure 3), driven by regional production hubs. In the US and Japan, the shares were only about one-fifth, reflecting their larger scope to source inputs from domestic providers but this was also the case for Italy, possibly reflecting efficient upstream domestic networks of small and medium enterprises. Interestingly, in 2009, Germany exported 25% more than the United States in gross terms but only 5% more in value-added terms.

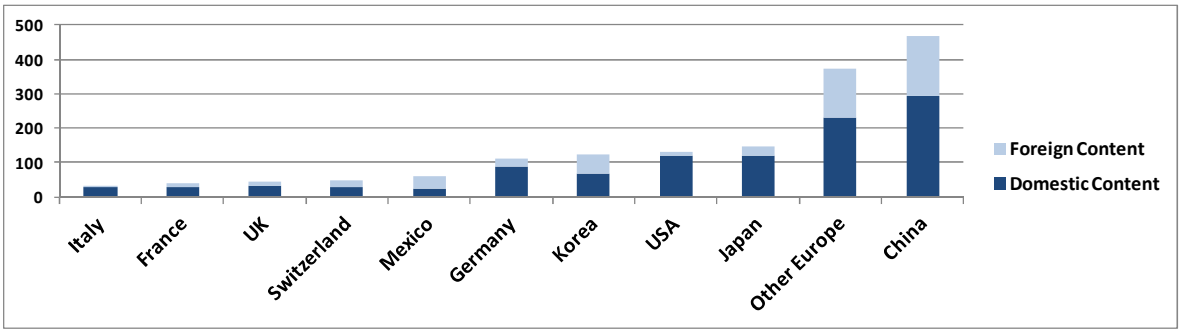
Figure 3: Transport equipment, gross exports decomposed by source , USD billion, 2009



Source: OECD-WTO Trade in Value Added (TiVA) indicators, Preliminary Results, OECD January 2013

Similar patterns emerge in other sectors with a high degree of international fragmentation. For example in China and Korea, in 2009, the foreign content of exports of electronic products was about 40% (Figure 4) and in Mexico, the share was over 60%.

Figure 4: Electronic equipment, gross exports decomposed by source , USD billion, 2009



Source: OECD-WTO Trade in Value Added (TiVA) indicators, Preliminary Results, OECD January 2013

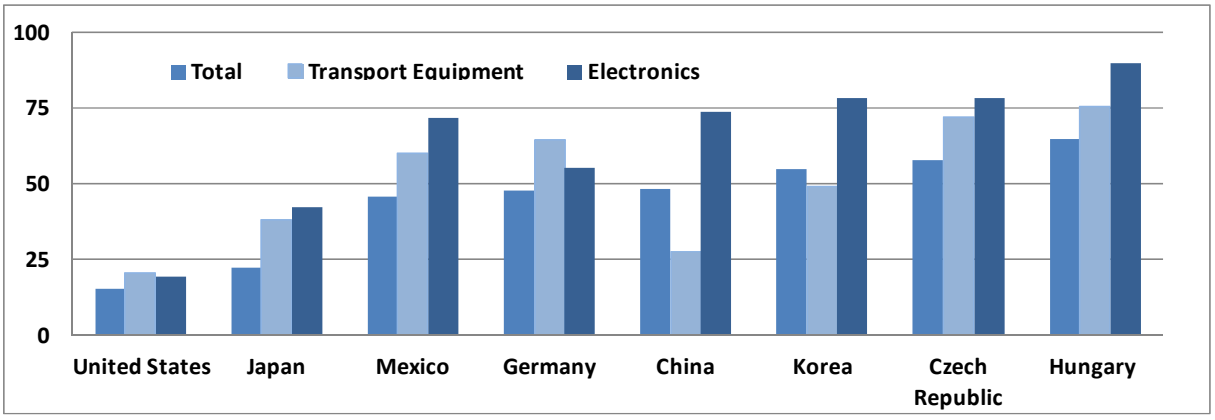
High shares of intermediate imports are used to serve export markets

The Figures above reveal that exporting firms require access to efficient imports in order to be competitive, and, so, highlight the potential counter-productive effects of protectionist measures. But an alternative way of indicating the adverse effects of such policies can be seen when looking at the overall share of intermediate imports that are used to serve export markets.

In most economies, around one-third of intermediate imports are destined for the export market. Not surprisingly, typically, the smaller the economy the higher the share, but even in the United States and Japan these shares are 15% and 20% respectively at the total economy level, with a higher incidence of intermediate imports in some highly integrated industries (Figure 5). In Japan for example nearly 40% of all intermediate imports of transport equipment end up in exports.

In many other countries, the share of intermediate imports embodied in exports is significantly higher. In Hungary, for example two-thirds of all intermediate imports are destined for the export market after further processing, with the share reaching 90% for electronic intermediate imports. In China, Korea and Mexico around three-quarters of all intermediate imports of electronics are embodied in exports. The database also shows that close to 85% of China's intermediate imports of textile products end up in exports.

Figure 5: Intermediate Imports embodied in exports, % of total intermediate imports, 2009



Source: OECD-WTO Trade in Value Added (TiVA) indicators, Preliminary Results, OECD January 2013

Open and efficient services markets matter

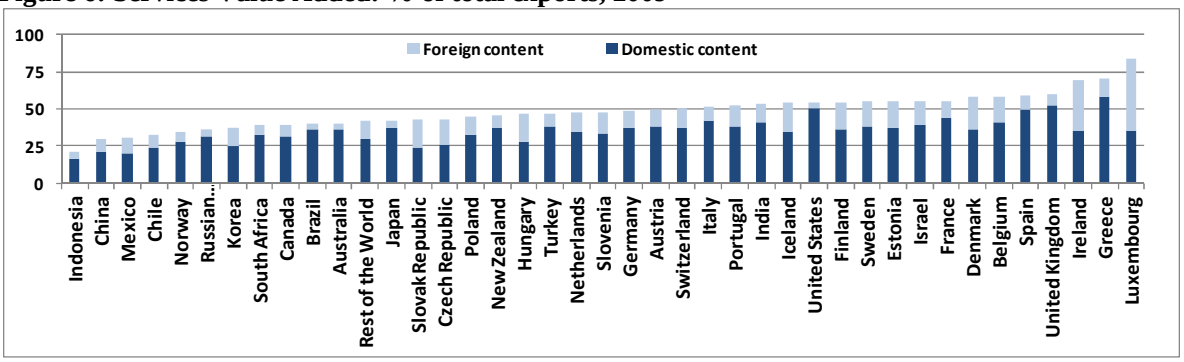
Services comprise about two-thirds of GDP in most developed economies. However, based on gross terms, trade in services typically account for less than one-quarter of total trade in most countries. This partly reflects the fact that significant shares of services output are generally not tradable, e.g. government services, many personal services and imputations such as those made in GDP calculations to reflect the rent homeowners are assumed to pay themselves (between 6-10% of GDP in most developed economies). But it also reflects the fact that the service sector provides significant intermediate inputs to domestic goods manufacturers.

Accounting for the value added produced by the services sector in the production of goods shows that the service content of total gross exports is over 50% in most OECD economies, approaching two-thirds of the total in the United Kingdom (Figure 6). Canada, with significant exports of natural resources, which have typically low services content, has the lowest services content of its exports in the G7 but even here the share is close to 40%.

Typically, emerging economies and other large exporters of natural assets, such as Norway, Chile and Australia, have the lowest shares of services. But in India over half of the value of its gross exports originates in the service sector. Indonesia has the lowest share of the 40 countries in the database at around 20%.

Part of the explanation for the difference between OECD countries and emerging economies reflects the relatively higher degree of (largely domestic) outsourcing of services by manufacturers in OECD countries in recent decades, suggesting that a similar process could lead to improvements in the competitiveness of emerging economy manufacturers. Figure 6 also reveals a not insignificant contribution to exports coming from foreign service providers.

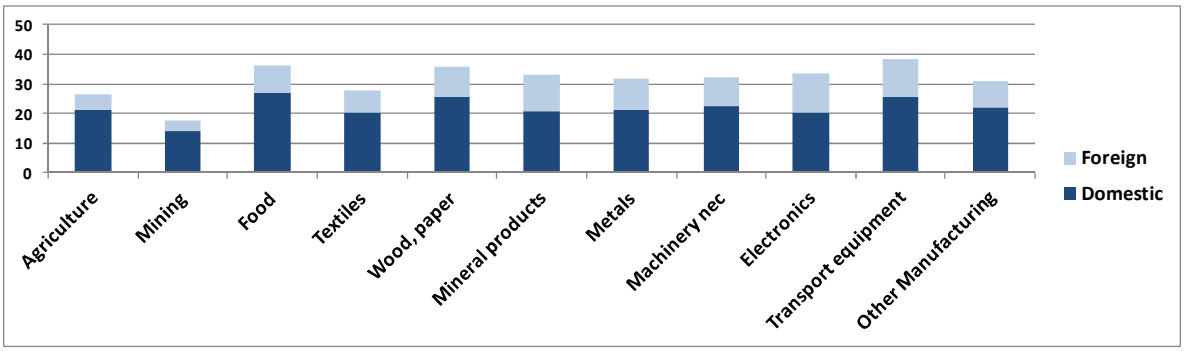
Figure 6: Services Value Added: % of total exports, 2009



Source: OECD-WTO Trade in Value Added (TiVA) indicators, Preliminary Results, OECD January 2013

Another, perhaps clearer way, of illustrating the importance of services to exports is to consider, the services content of specific exports in goods producing sectors. Figure 7 below, which takes an average of all 40 countries in the database, shows that services make a significant contribution (typically one-third) across all manufacturing sectors, with significant shares provided by both foreign and domestic service providers. For individual sectors in specific countries the importance of the service sector is often starker. In France, for example, the data reveals that over half of the domestic value-added generated in producing transport equipment originates in the French service sector.

Figure 7: Services Value Added: % of total exports of goods, 2009

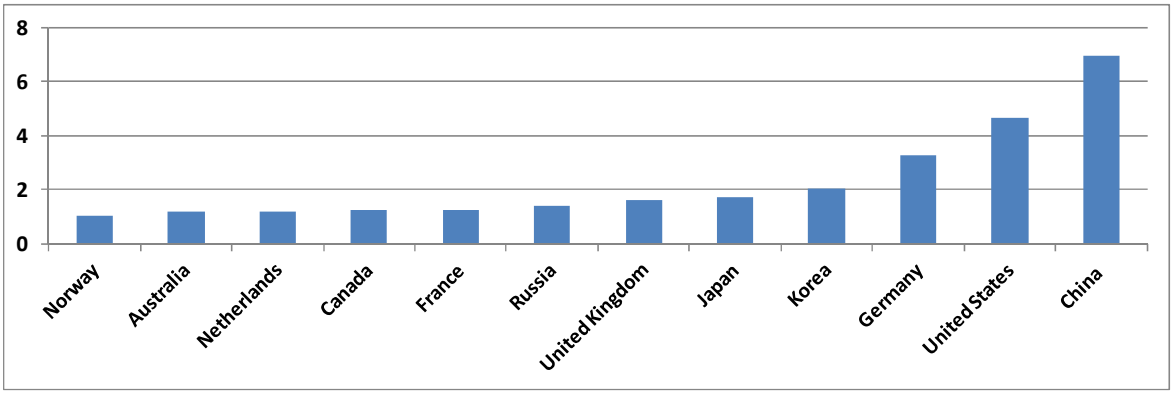


Source: OECD-WTO Trade in Value Added (TiVA) indicators, Preliminary Results, OECD January 2013

Intermediate imports often embody a country's own (returned) domestic value-added

Imports can also contain 'returned' value-added that originated in the importing country. The preliminary, and one should stress conservative, estimates show that in the United States, for example, nearly 5% of the total value of imported intermediate goods reflects US value-added (Figure 8) and in China the equivalent shares are close to 7%. For electronic goods, Chinese intermediate imports contain over 12% of "returned" Chinese domestic value-added, and Korean intermediate imports contain close to 5% of "returned" Korean domestic value-added.

Figure 8: Domestic content of imports: % of total intermediate imports, 2009

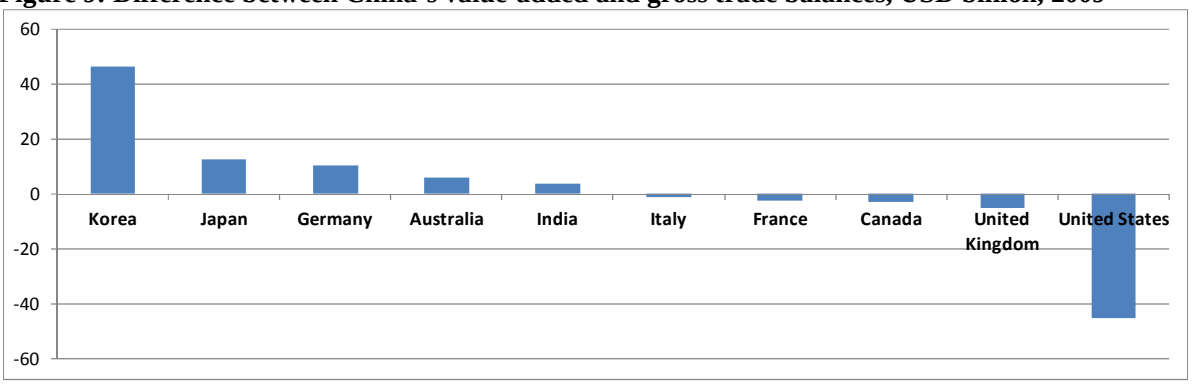


Source: OECD-WTO Trade in Value Added (TiVA) indicators, Preliminary Results, OECD January 2013

What you see is not what you get: Trade patterns change

Bilateral trade balance positions can change significantly when measured in value-added terms, although the total trade balance is unaffected. China's bilateral trade surplus with the United States was over USD 40 billion (25%) smaller in value-added terms in 2009 for example (and 30% smaller in 2005). This partly reflects the higher share of US value-added imports in Chinese final demand but also the fact that a significant share (one-third) of China's exports reflect foreign content - the "Factory Asia" phenomenon. The data illustrates that significant exports of value-added from Korea and Japan pass through China on their way to final consumers, resulting in significantly smaller Chinese trade deficits with these countries but also typically higher Japanese and Korean trade surpluses with other countries. Similarly the database shows that Korea's significant trade deficit with Japan in gross terms almost disappears when measured in value-added terms

Figure 9: Difference between China's value-added and gross trade balances, USD billion, 2009



5. Estimating Trade in Value Added

5.1 How?

As mentioned above, several initiatives and efforts have tried to address the issue of the measurement of trade flows in the context of the fragmentation of world production.[8] The most commonly used approach to develop a macro picture is based on global input-output tables, using simple standard Leontief inverses, more detail can be found in OECD-WTO, (2012)[9] and in Annex I.

Constructing the global table is a data-intensive process and presents numerous challenges. The key challenge is to identify and create links between exports in one country and the purchasing industries (as intermediate consumption) or final demand consumers in the importing country. In this respect it's important to note that the data issues faced by the OECD are similar to those confronted by other initiatives, such as IDE-JETRO (Asian Input-Output Tables) or the World Input Output Database project, with whom (as well as the US-ITC) the OECD and WTO have been coordinating actively in order to share experiences and derive a set of best practices.

The data sources at OECD are harmonised input-output tables and bilateral trade coefficients in goods and services, derived from official sources.[10] The model specification and estimation procedures can be summarized as follows:

- Preparation of I-O tables for reference years using the latest published data sources e.g. Supply and Use tables (SUTs), National Accounts and trade statistics;

- Preparation of bilateral merchandise data by end-use categories for reference years. The published trade statistics are adjusted for *analytical* purposes (such as confidential flows, re-exports, waste and scrap products and valuables). Trade coefficients of utility services are estimated based on cross border energy transfers. Other trade coefficients of service sectors are

8 . An OECD-World Bank workshop on "new metrics for global value chains" was organised on 21 September 2010. WTO hosted a Global Forum on Trade Statistics on 2-4 February 2011, in collaboration with Eurostat, UNSD and UNCTAD.

9 Trade in value-added: concepts, methodologies and challenges, OECD-WTO, 2012.

10 . Some research oriented initiatives have been using the GTAP data base for international input-output data. This is not however based on official sources of statistics,

based on OECD Trade in Services and UN Service Trade statistics. However, many missing flows are currently estimated using econometric model estimates;

- Conversion of c.i.f. price based import figures to f.o.b. price based imports to reduce the inconsistency issues of mirror trade (because of asymmetry in reporting exports and imports in national trade statistics, imports of country A from B often differ significantly from the exports reported from B to A). In an international I-O system, trade flows need to be perfectly symmetric (the bilateral trade flows should be consistent at the highest relevant level of disaggregation) and consistent with the supply-utilization tables trade data;

- Creation of import matrices ;

- Total adjustment (missing sectors, trade with rest of the world, etc) and minimization of discrepancy columns using bi-proportional methods;

The OECD has been updating and maintaining harmonised I-O tables, splitting intermediate flows into tables of domestic origin and imports, since the mid-1990s - usually following the rhythm of national releases of benchmark I-O tables. The first edition of the OECD I-O Database dates back to 1995 and covered 10 OECD countries with I-O tables spanning the period from the early 1970s to the early 1990s. The first updated edition of this database, released in 2002, increased the country coverage to 18 OECD countries, China and Brazil, and introduced harmonised tables for the mid-1990s. The database now includes national IO tables for 57 economies[11] (Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States, Argentina, Brazil, China, Chinese Taipei, Cyprus, India, Indonesia, Latvia, Lithuania, Malaysia, Malta, Romania, Russian Federation, Singapore, South Africa, Thailand, and Viet Nam).

The I-O tables show transactions between domestic industries but, as a complement, supplementary tables, which break down total imports by user (industry and category of final demand) are included. Some countries provide these import tables in conjunction with their I-O tables but in some cases they are derived by the OECD.

Measuring trade in value added relates to industries' activity rather than to products, as in conventional trade statistics. The OECD's input-output tables are based on an industry by industry basis reflecting the fact that the underlying source data measures the activities and production of industries, which means that the relationships between value-added and industrial output are unaffected by statistical manipulations that will be required to build product by product based input-output tables.. The industry classification used in the current version of OECD's I-O database is based on ISIC Rev.3 (Table 1), meaning that it is compatible with other industry-based analytical datasets, and in particular with the OECD bilateral trade in goods by industry dataset (derived from merchandise trade statistics via standard Harmonised System to ISIC conversion keys). The system, by necessity (*i.e.* to maximise cross country comparability), is relatively aggregated. Differentiating between types of companies within a given sector is essential however to improve the quality of trade in value-added results (particularly in the context of exporting and non-exporting companies), and, so, part of future work will be to explore ways, using micro-data that could improve the quality of results, see below.

11 . For more details, see also www.oecd.org/sti/inputoutput.

Table 1. OECD Input-Output industry classification

ISIC Rev.3 code	Description
1+2+5	1 Agriculture, hunting, forestry and fishing
10+11+12	2 Mining and quarrying (energy)
13+14	3 Mining and quarrying (non-energy)
15+16	4 Food products, beverages and tobacco
17+18+19	5 Textiles, textile products, leather and footwear
20	6 Wood and products of wood and cork
21+22	7 Pulp, paper, paper products, printing and publishing
23	8 Coke, refined petroleum products and nuclear fuel
24ex2423	9 Chemicals exluding pharmaceuticals
2423	10 Pharmaceuticals
25	11 Rubber and plastics products
26	12 Other non-metallic mineral products
271+2731	13 Iron & steel
272+2732	14 Non-ferrous metals
28	15 Fabricated metal products, except machinery and equipment
29	16 Machinery and equipment, nec
30	17 Office, accounting and computing machinery
31	18 Electrical machinery and apparatus, nec
32	19 Radio, television and communication equipment
33	20 Medical, precision and optical instruments
34	21 Motor vehicles, trailers and semi-trailers
351	22 Building & repairing of ships and boats
353	23 Aircraft and spacecraft
352+359	24 Railroad equipment and transport equipment n.e.c.
36+37	25 Manufacturing nec; recycling (include Furniture)
401	26 Production, collection and distribution of electricity
402	27 Manufacture of gas; distribution of gaseous fuels through mains
403	28 Steam and hot water supply
41	29 Collection, purification and distribution of water
45	30 Construction
50+51+52	31 Wholesale and retail trade; repairs
55	32 Hotels and restaurants
60	33 Land transport; transport via pipelines
61	34 Water transport
62	35 Air transport
63	36 Supporting & auxiliary transport activities; activities of travel agencies
64	37 Post and telecommunications
65+66+67	38 Finance and insurance
70	39 Real estate activities
71	40 Renting of machinery and equipment
72	41 Computer and related activities
73	42 Research and development
74	43 Other Business Activities
75	44 Public administration and defence; compulsory social security
80	45 Education
85	46 Health and social work
90-93	47 Other community, social and personal services
95+99	48 Private households and extra-territorial organisations

In essence, a global IO table is little different to a national IO table except that while the matrix of flows of intermediate goods and services in a national table can be industry x industry, in an global IO table, the rows and columns are country-industry combinations. In addition in a global IO table there are separate columns for each country's final demand. A two country, two sector representation is shown below for illustration in Figure 10.

Figure 10. A simplified ICIO system

		Country A		Country B		Final Demand	
		Sector 1	Sector 2	Sector 1	Sector 2	Country A	Country B
Country A	Sector 1: Goods	Z_{11}^{AA}	Z_{12}^{AA}	Z_{11}^{AB}	Z_{12}^{AB}	F_1^{AA}	F_1^{AB}
	Sector 2: Services	Z_{21}^{AA}	Z_{22}^{AA}	Z_{21}^{AB}	Z_{22}^{AB}	F_2^{AA}	F_2^{AB}
Country B	Sector 1: Goods	Z_{11}^{BA}	Z_{12}^{BA}	Z_{11}^{BB}	Z_{12}^{BB}	F_1^{BA}	F_1^{BB}
	Sector 2: Services	Z_{21}^{BA}	Z_{22}^{BA}	Z_{21}^{BB}	Z_{22}^{BB}	F_2^{BA}	F_2^{BB}
Tax less subsidy on products		NTZ_1^{A}	NTZ_2^{A}	NTZ_1^{B}	NTZ_2^{B}	NTF^{A}	NTF^{B}
International trade margin and insurance		TIZ_1^{A}	TIZ_2^{A}	TIZ_1^{B}	TIZ_2^{B}	TIF^{A}	TIF^{B}
Value-	Labor compensation	VL_1^{A}	VL_2^{A}	VL_1^{B}	VL_2^{B}		
Added	Operating surplus	VO_1^{A}	VO_2^{A}	VO_1^{B}	VO_2^{B}		
	Tax less subsidy on production	VT_1^{A}	VT_2^{A}	VT_1^{B}	VT_2^{B}		
Output		X_1^{A}	X_2^{A}	X_1^{B}	X_2^{B}		

Most of the components intuitively follow from the row and column headings but for ease of exposition:

Z_{12}^{AB}: Intermediate purchase by Sector 2 of country B from sector 1 of Country A.

F_1^{AB}: Final demand of consumers in Country B of output of sector 1 in country A.

Typically in the above, statistics offices are able to provide most of the blocks required (recalling that supply-use tables can be readily converted to the above format, and, moreover, that the above format can be initially constructed as a global supply-use table, which will form the long term approach to be used by the OECD). But, even though some countries are able to estimate the overall imports of a given product used by a particular industry, many are not and none are able to show, systematically, the source of that import (by originating country and industry) by the using industry (or final demand category).

Central to the construction of a global input-output table therefore is the estimation of trade flows between industries and consumers across countries. Indeed, these trade flows in intermediate goods and services are the glue which tie together the national individual input-output tables. A positive spin-off of the work is worth mentioning in this content. National estimates of trade (exports and imports) are not coherent across countries (even after adjusting for price differences, c.i.f., f.o.b, and as such the process of constructing a global IO table confronts this issue head on. The spin-off to the work is therefore a mechanism to reveal where global imbalances lie, with the results and policy implications of the work highlighting the importance that should be attached to reconciling these flows at the national level. This will form an important part of the OECD's work programme, through its Working Party on Trade in Goods and Services, over the coming years.

5.2.1 Bilateral Trade in Goods and Services and IO balancing

Given the fact that many imports enter countries through intermediaries (wholesalers) It is highly unlikely that countries will ever be able to collect statistics that systematically show the country source of all imports consumed by all industries nor does it seem likely that countries will be able to show which foreign industries consume their products. But as shown below it is possible, at least in the medium term, for countries to do more in this field by capitalising on microdata and links between trade and business registers.

In the short term however, more can be, and is being, done to improve how imports are allocated to using industries. Most countries are able to produce estimates of bilateral trade in goods and services showing the export of a given good or service to a given partner country and indeed most countries are able to further

reveal whether any particular import or export of a good (for most imports and exports) was intermediate, investment, or a consumer good.

In constructing the import flows (and export flows) of its global IO table the OECD necessarily uses a number of assumptions. The main assumption used in creating these import matrices is the 'proportionality' assumption, which assumes that the (country) origin share of a given import consumed by a given industry in a given country is the same for all industries that in that country. For countries which are not able to provide any ' import-flow' matrices at all (i.e. the intermediate consumption of imports by product (or industry) by industries, the OECD necessarily assumes that the share of intermediate imports in total intermediate consumption for a given imported product is the same for all using industries (and is equivalent to the overall share of intermediate imports to total intermediates supplied for that product). In all cases the OECD has been able to significantly improve the quality of the assumptions it necessarily uses by creating a new database of bilateral trade (for goods) that breaks down imports (and exports) on the basis of the nature of the traded product (intermediate, household, investment, other): *Bilateral Trade Database by Industry and End-Use Category*[12], (BTDIxE), derived from United Nations Statistics Division (UNSD) UN COMTRADE database, where values and quantities of imports and exports are compiled according to product classifications and by partner.

COMTRADE data are classified by declaring country (*i.e.* the country supplying the information), by partner country (*i.e.* origin of imports and destination of exports), and by product (*i.e.* according to Harmonized System (HS)). Trade flows are stored according to the product classification used by the declaring country at the time of data collection. In general, source data are held according to Standard International Trade Classification (SITC) Rev. 2 for the time period 1978-1987, the Harmonized System (1988) for 1988-1995, HS Rev. 1 (1996) for 1996-2001, HS Rev. 2 (2002) for 2002-2006 and HS Rev.3 (2007) from 2007 onwards.

To generate estimates of trade in goods by industry and by end-use category, 6-digit product codes from each version of HS from COMTRADE are assigned to a unique ISIC Rev.3 industry and a unique end-use category- and hence SNA basic classes of goods, (see Table 1 below).

Table 2. Current BEC and SNA classes of goods

		End-use			
			Final demand goods		
		Intermediate	Household consumption	Industrial capital goods	Other
Products characteristics	Primary products	Food and beverages (111) Industrial supplies (21) Fuels and lubricants (31)			
			Food and beverages (112)		
	Processed unfinished		Food and beverages (122)		
		Fuels and lubricants e.g. gasoline (32)			
		Food and beverages (121) Industrial supplies (22) Parts and components of transport equipments (53) Parts and components of capital goods (42)			
	Processed finished	Packed medicaments (part of 63)			
			Non-industrial transport equipments (522) Non durable consumer goods (63) Semi-durable consumer goods (62) Durable consumer goods for households (61)		
			Durable personal consumer goods e.g. personal computers (part of 61), Mobile phones (part of 41) Passenger motor cars (51) Fixed line phones (part of 62)		
				Capital goods (41) Industrial transport equipments (521)	
	Other				Goods n.e.c (7)

[12] For more details, see www.oecd.org/sti/btd

Sources: http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=10&Lg=1
Note: Numbers are BEC code

Notwithstanding the known problems relating to the asymmetries that exist within bilateral trade statistics (i.e. global exports do not equal global imports) these bilateral statistics form the basis for populating the international flows in goods used in the OECD's global input output above, before balancing (see below).

The approach used for bilateral trade in services statistics is at heart similar - estimates based on official bilateral statistics form the basis for the original estimates of exports and imports by country. However the quality of bilateral trade in services statistics is notoriously poor and so the original partner share coefficients used to populate IO cells of international trade in services are based on Gravity model techniques (see Miroudot, Lanz, and Ragoussis, 2009), which are subsequently balanced within the overall system.

Only very few countries have a consistency between bilateral trade flows (imports and exports) by partner country and the corresponding flows shown in their supply-use table (the basis for the creation of national IO tables), reflecting the fact that, for goods at least, bilateral trade flows follow merchandise trade accounting standards. As such there are a number of recommendations that follow for official statisticians:

- Producing bilateral trade flows that are consistent with underlying supply-use tables should form a high priority of national statistics offices.
- Confidential trade: In some countries disclosure rules suppress 6-digit HS components in COMTRADE and also higher 2-digit HS *chapter* levels. This should be avoided where possible with other forms of preserving confidentiality adopted, such as suppressing another 6-digit category.
- Re-exports: Adjustments are required for re-exports_which are significant for major continental trading hubs. Sufficient data are available in order to adjust for reported trade between China and the rest of the world via *Hong Kong*, but not currently for other major hubs such as Belgium, Netherlands and Singapore.
- Identifying used/second-hand capital goods: HS codes, and thus reported trade in COMTRADE cannot differentiate between new and old capital goods (such as second-hand aircraft and ships). Estimating international trade in these flows in a value-added context requires an elaboration of the input-output framework that allows these flows to be recorded in a way that aligns with total global value-added produced in a given period.
- Unidentified scrap and waste**:** Certain types of waste and scrap do not have separate 6-digit HS codes – *e.g.* PCs and other electrical equipment exported (often to developing countries) for recycling.
- Moreover, for services, countries are encouraged to provide more detail on partner countries and also to on the type of products (following EBOPS 2012).
- Greater efforts are needed to reconcile asymmetries in international trade flows.

Notwithstanding the resolution and implementation of the issues and recommendations set out above the OECD's global input-output table necessarily balances global discrepancies in trade using a quasi automatic (RAS) balancing procedure, constraining each country's exports and imports to published national accounts totals (whilst also constraining estimates of national GDP). This is a work in progress and efforts to improve the nature of the balancing process are on-going see (Ahmad, Wang and Yamano, 2013) .

From the above, it is important to stress that the indicators shown in the database are **estimates**. Official gross statistics on international trade produced by national statistics institutions result in inconsistent figures for total global exports and total global imports; inconsistencies which are magnified when bilateral partner country positions are considered. The global input-output tables from which trade in value added indicators are derived, necessarily eliminate these inconsistencies, such as those that reflect different national treatments of re-exports and transit trade (e.g. through hubs such as the Netherlands and Hong Kong), to achieve a coherent picture of global trade. For the countries for which data is presented, total exports and imports are consistent with official national accounts estimates.

5.2.2. Level of detail in national Supply-Use and/or Input-Output tables - Future Improvements

Indicators created via input-output techniques are limited by the degree of industry disaggregation provided by the tables. The national input-output tables used by the OECD are based on a harmonised set of 37 industries. In simple terms therefore, any given indicator for a particular industry assumes that all consumers of that industry's output purchase exactly the same shares of products produced by all of the firms allocated to that industry.

This boils down in practice, (but is not the same thing) to assuming that there exists only one single production technique for all of the firms (and all of the products) in the industry grouping. We know that this is not true and that different firms, even those producing the same products, will have different production techniques, and, so, technical IO coefficients, and we also know that different firms produce different products and that these products will be destined for different types of consumers and markets.

Of chief concern in this respect is the evidence that points to exports having very different coefficients to goods and services produced for domestic markets, particularly when the exports (typically intermediate) are produced by foreign owned affiliates in a global value chain. Because exporting firms are generally more integrated into value-added chains they will typically have higher foreign content ratios, particularly when they are foreign owned. Generally, therefore, an ability to account for this heterogeneity in producing trade in value-added estimates will generally result in lower shares of foreign content than might be recorded if more detailed input-output tables were available.

But it is important to note, however, that more detail does not necessarily translate into more disaggregated industries. What is important for developing indicators on global value chains is more detail on firms trading internationally. In this sense, given a choice between doubling the number of industries available within current national IO or SU tables or providing a split of existing industries into a group of exporting firms and non-exporting firms, the latter may arguably be preferable.

Ideally therefore countries should attempt to construct Supply-Use or Input-Output tables that better respond to the challenges presented by GVCs. In a project coordinated by the Chinese Ministry of Commerce, in collaboration with the Chinese National Bureau of Statistics, and the OECD, an input-output table for China was created that split all of its industrial sectors into three categories - processing firms, other exporting firms, and all other firms (see Cuihong, 2013).

Ideally countries could adopt similar approaches in constructing their IO and/or SU tables, with splits based on national circumstances. Processing firms form a significant part of China's exporters and so such a classification made sense in the case of China but this may not be optimal for all countries. But achieving changes to national IO or SU tables may take some time to achieve for most countries.

Other, potentially simpler, approaches however could be used to significantly improve the quality of the information IO tables are able to produce in analysing GVCs however.

In October 2012 the OECD and Eurostat launched one such approach by building on the OECD-Eurostat TEC (Trade by Enterprise Characteristics) data collection. The TEC exercise collects information on the turnover generated through exports broken down by size class, industry and partner country. For imports similar information is provided but with a more limited breakdown on the importing industry. But these indicators only begin to scratch at the surface of the potential, if links to structural business statistics can be made (see, Ahmad, Araujo, Lo Turco and Maggioni, 2013). With these further links, information on the direct value-added of exporting firms can be created, as can information on employment. In addition indicators broken down by whether the firms are foreign or domestically owned can also be created; which are important additional breakdowns required for analyses of ' trade in income', see below. Moreover information that linked the information on importing firms with those of exporting firms can provide vital information on the nature of global production chains. Importantly, for those countries that already produce TEC statistics, this information, albeit on the basis of turnover flows, could be developed without necessarily using links to structural business statistics. This information could form the basis for disaggregating IO or SU industries into characteristics required to better measure GVCS.

The questionnaire circulated to test the feasible and practical level of detail that could be collected, bearing in mind disclosure rules, focused only on export intensities (rather than import intensities, where it was recognised that this would need to form a later step). The primary purpose of the questionnaire was to categorise firms on the basis of their share of output generated by exports (export intensities). Three different levels of breakdown were requested, with countries requested to use the breakdown that best suited their disclosure rules (and resources):

- Firms that export (more than 0% of output is made up by exports) and firms that don't (0% of output is exported)
- A breakdown of firms by export-intensity quartiles: (0%, >0- 25%; >25-50%, >50-75%; and 75% plus)
- A more aggregated breakdown of export intensity (0, >0-50%; 50% plus).

Seven variables, described below, were requested in the exercise, with each broken down by industry, size class and ownership. But recognising that disclosure rules would restrict what can realistically be produced for public consumption, countries were asked to prioritise their information on the following lines:

- Priority 1: Industries (Preferably, ISIC rev. 4) for 2 digit groupings
- Priority 2: Export intensities (exports as a per cent of output)
- Priority 3: Ownership (breakdowns into foreign/domestic ownership)
- Priority 4: Size Class breakdowns (preferably by number of employees)
- The variables requested were:
    - **the number of statistical units participating or otherwise in exports,** ideally using a concept consistent with that used in preparing supply-use and input-output tables.
    - **the value-added generated by firms in national currency units,** ideally at basic prices.
    - **the value of exports generated by firms in national currency units**, ideally f.o.b prices.
    - **the output generated by firms in national currency units,** ideally at basic prices.

- **the total employment of firms,** ideally on a Full Time Equivalent basis.
- **the total Compensation of Employees of firms.**
- **direct imports of firms in national currency units,** ideally at c.i.f. prices.

5.3 Accounting Extensions for (going beyond) Trade in Value-Added Beyond

Looking at trade in value-added terms provides a valuable insight into broader notions of competitiveness (in addition to providing insights into trade policies) by illustrating interlinkages between countries and also by illustrating those activities (or tasks) that generate the most value. But additional indicators and insights can be gained by considering extensions to the accounting framework.

5.3.1 Trade in Jobs

One immediate area relates to jobs. This requires consistent estimates of employment measures (employment, employers, actual hours worked) with the underlying value-added estimates produced by national statistics offices in their supply-use tables.

Countries have already begun to make improvements in this area, driven by a need to produce coherent productivity estimates (by industry), and it is hoped highlighting the important insights that can be gained by looking at trade in jobs will reinforce and support these national initiatives aimed at improving coherence. Going a step further, particularly because international fragmentation has meant industries across countries are less comparable than they used to be (as countries specialise in those stages of the underlying activity where they have comparative advantage) it is increasingly becoming necessary to link jobs statistics to skills statistics.

The OECD's ANSKILL database (forthcoming) provides information on employment and skill composition at the industry level. The database matches industry data at the 2-digit level (classified according to the International Standard Industrial Classification [ISIC] Revision 3) to occupations at the 2-digit level (classified according to the International Standard Classification of Occupations [ISCO] – 88). It also includes an additional proxy for skills, in the form of data on educational attainment of employees (classified on the basis of the International Standard Classification of Education [ISCED-97]). The database covers 26 countries, mostly for 1997-2005 although coverage of seven of the countries is much more limited.

For ANSKILL, the ISCO-88 occupation classification maps to high, medium and low skill levels, as follows:

- Categories 1 (Legislators, senior officials, managers), 2 (Professionals) and 3 (Technicians and associate professionals) are regarded as high-skilled.
- Categories 4 (Clerks), 5 (Service workers and shop and market sale workers), 6 (Skilled agricultural and fishery workers) and 7 (Craft and related trade workers) are regarded as medium-skilled.
- Categories 8 (Plant and machine operators and assemblers) and 9 (Elementary occupations) are regarded as low-skilled.

The ISCED-97 educational classification maps to high, medium and low skill levels in ANSKILL as follows:

- Categories 1 (Primary education) and 2 (Lower secondary/second stage of basic education) are regarded as low-skilled.
- Categories 3 (Upper secondary education) and 4 (Post-secondary non-tertiary education) are regarded as medium-skilled.

• Categories 5 (First stage of tertiary education) and 6 (Second stage of tertiary education) are regarded as high-skilled.

5.3.2 Trade in Income

Conventional trade statistics do not always record transactions between affiliates as sales-purchases of goods and services. This is especially the case for intellectual property products.

Consider for example an affiliate enterprise, recognised in the national accounts of its resident economy as the economic owner of an IPP that it uses to produce goods it sells. The affiliate's value-added would reflect in part the return on this underlying asset, realised as profits (operating surplus). These profits would subsequently be recorded as reinvested earnings whether or not any actual flows occur between the parent and its affiliate. Ultimately therefore it is the parent (often the entity that finances the underlying IPP) that benefits from the use of the IPP (indeed this in itself raises questions about how economic ownership of IPPs should be considered in respect of multinationals - an issue that is currently being tackled by the international statistics community).

But the difficulties raised by the current recording of IPPs in the balance of payments and national accounts of countries extend beyond this simple example (which correctly records flows in line with current standards and guidelines). Often, for example, the national accounts in the economy of the parent company will record the asset but there will not be any flows related to the use the owner makes to its affiliates; often driven by tax minimisation purposes. And again, often, the owner may transfer the asset to an affiliate (such as a Special Purpose Enterprise), with the parent and other affiliates making explicit payments to the SPE, again driven by tax minimisation purposes.

What is clear from the above therefore, is that flows related to IPPs require an extension of accounting systems beyond looking merely at value-added flows in order to fully understand who benefits from trade and indeed trade liberalisation (and investment). Sometimes these flows will increase value-added, sometimes they will not. But in both cases the beneficiary is arguably the same (the parent company).

But the flows merely illustrate a wider issue, notwithstanding the obvious implications it raises for multifactor productivity calculations. Firstly they illustrate the potential distortions that may arise when one factors in the scope for transfer pricing manipulations. Secondly, such interpretations extend beyond looking only at the conventional set of assets recognised as such in the 2008 SNA. Other knowledge based assets, such as brands and organisational capital can also increase an affiliate's value-added and even though these assets are not recognised in the SNA, the profits recorded by the affiliate compensate for their use, but these still flow back to the parent, eventually, as reinvested earnings flows in the accounts. But these flows are typically not available on a bilateral partner country basis let alone partner country-industry basis; which is what is needed for analyses of trade in income in an analogous way to trade in value-added.

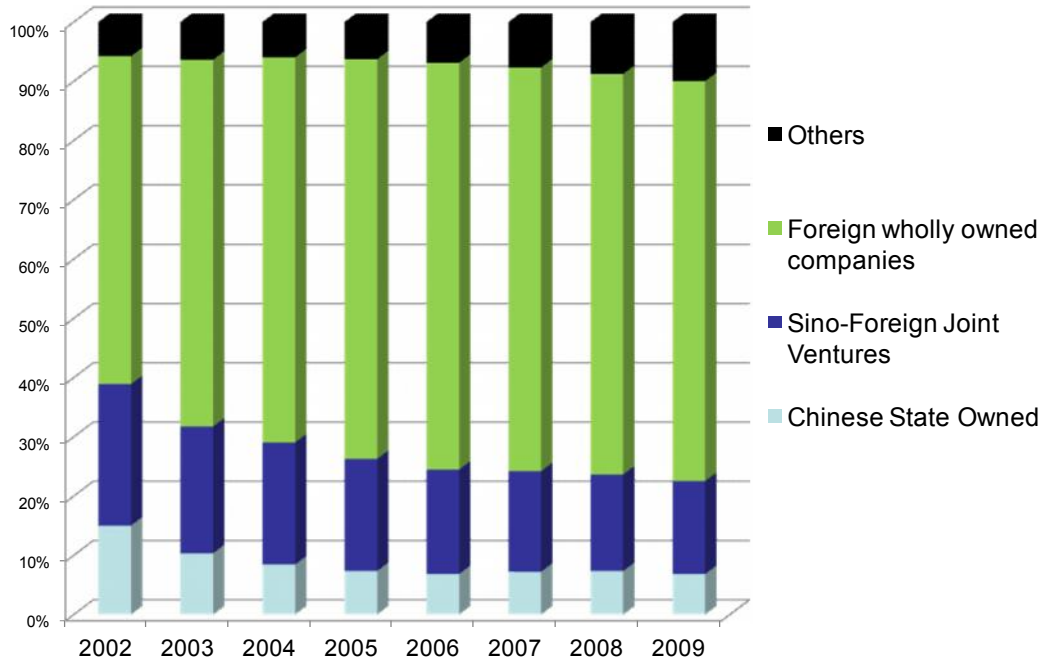
Recording these flows therefore is crucial. Part of the solution lies in producing supply-use tables (or indicators) that capture foreign ownership. Clearly it is unlikely to be feasible to produce supply-use tables that capture foreign ownership by (all of the affiliates' owners') country. But a separate breakdown of activities in a supply-use table that differentiates between foreign and domestic owned firms should be feasible, vis-a-vis confidentiality rules and burdens.

By supplementing this with bilateral trade in primary income (from whom-to-whom) statistics (broken down by type of income (in particular, reinvested earnings and interest) it should be possible to create extensions to the trade in value-added accounting framework by treating the primary income flows (and components) as if they were services produced by artificial industries in the host country of the parent company.

Some of the tools to do this already exist. Foreign Affiliate Trade statistics can be combined for example with information in supply-use tables that shows breakdowns based on ownership. And there is also scope to link this further to BoP data flows. The OECD is looking at developing a more detailed accounting framework and set of recommendations in this area, which could form the basis of estimating flows of trade in income.

To illustrate the potential impact of accounting for these flows between multinationals, consider the following: About 70% of China's gross hi-tech exports were made by foreign affiliates in 2009 (Figure 11). Between 1995 and 2007, Japanese foreign affiliates increased their employment in China eightfold from just over 100,000 employees to over 1000,0000 and by 300,000 (to over 400,000) in Thailand, with similar patterns in other ASEAN countries, such as the Philippines, Malaysia and Indonesia. Over the same period to 2009, Japan's primary income trade surplus increased by around $100 billion more than offsetting the $50 billion reduction in its gross trade surplus over the same period.

Figure 11: Chinese High Tech Exports by Ownership (%)



Source: Ministry of Commerce, China

5.3.3 Trade in CO2 (and other emissions)

One additional extension that follows from the accounting framework for trade in value-added (and trade in jobs) is carbon footprints. Carbon footprint calculations are typically estimated using IO tables (see Ahmad, Wyckoff, 2003).

5.3.4 Incorporating capital flows

Other areas where extensions to the accounting framework would be desirable include the contribution made by capital more generally. Because of the way capital (gross fixed capital formation) is recorded in the accounting system (as gross fixed capital formation) analyses that look at trade in value-added do not fully capture how production across countries is linked and how capital goods (and services) produced in one country contribute to the value-added in another. For example all the value-added exported by Japan in producing machinery for manufacturers in China will be recorded as Chinese imports from Japan. But arguably the capital service values embodied in the goods produced and exported by China should show Japan as the beneficiary. This requires high quality capital flow (and capital stock) matrices.

5.3.5 Distribution sectors and trade

One final area of work that merits attention concerns the value added by distributors via sales of final imported goods. The estimates of Trade in Value-Added do not reveal how cheap imports are also important to retailers, who are able to generate domestic value-added via sales to consumers. Tariff measures will necessarily impose additional costs on these goods which, all other things being equal, could suppress demand and so in turn lead to lower value-added in the distribution sectors. The OECD is also considering how these estimates could be incorporated within its accounting framework using and motivating the development of margin rates for all products in national supply use tables.

ANNEX I - INDICATOR DESCRIPTIONS AND DEFINITIONS

In the first release of the OECD-WTO TiVA database, the following indicators were provided for 40 countries (OECD countries, Russian Federation, Brazil, China, India, Indonesia, and South Africa) with a breakdown into 18 industries.

Gross Trade Indicators

Variable Name	Variable Description	Comments
EXGR	Gross Exports by Industry, USD	All variables are consistent with official National Accounts estimates of total gross exports and total gross imports and GDP estimates. Estimates by Industry are based on the balanced pattern of trade derived within the global input-output database (see below). *Bilateral gross trade flows (between partner countries) of exports and imports are not shown as current official statistics on bilateral trade are not globally coherent. The global input-output table underlying the TiVA database imposes coherence in bilateral gross flows, which may be released in future database releases after consultation with national statistics institutes (NSIs).* The underlying gross bilateral trade statistics used to arrive at the balanced picture of trade in the TiVA database are however available for both goods (OECD's *Bilateral Trade by Industry and End-Use database* BTDIxE) and services (OECD's *Trade in Services by Partner Country database*, TISP) and can be found on the OECD's statistics portal OECD.Stat.
IMGR	Gross Imports by Industry, USD	
EXGR_GDP	EXGR as a per cent of GDP	
IMGR_GDP	IMGR as a per cent of GDP	
TSGR	Bilateral Trade balances by Partner Country, USD	TSGR is equivalent to EXGR minus IMGR. Bilateral trade positions in TSGR are also shown in the TiVA database. These bilateral trade balances broadly align with 'official' bilateral trade balances produced by NSIs. However there are often differences between TiVA estimates and these 'official' estimates'. These reflect: • Treatment of re-exports and transit trade through e.g. Netherlands, Hong Kong, China, Singapore and NAFTA. • Global inconsistencies between exports and imports of trade in goods and services between partner countries, reported in official statistics. • Coverage and quality issues, particularly in official bilateral trade in services statistics, such as missing data. The main focus for bilateral trade balances in the TIVA database should be on differences between TSGR and TSVAFD (see TSVAFD-TSGR).
TSGR_GDP	TSGR as a per cent of GDP	

Gross Trade Decomposition (Value-Added embodied in Gross Trade Flows)

Variable Name	Variable Description	Comments
EXGRDVA	Total Domestic Value-Added embodied in gross exports (by Industry), USD	Total Domestic value-added content of exports is broken down into three components, described below as EXGR_DDC, EXGR_IDC and EXGR_RIM).
EXGRDVA_EX	EXGRDVA as per cent of EXGR (by Industry), %	This reflects the domestic value-added embodied in exports as a per cent of exports. It provides a simple measure that illustrates how much value-added is generated throughout the economy for a given unit of exports. The lower the ratio the higher the foreign content and so the higher the importance of imports to exports.
EXGR_DDC	Direct Industry Value-Added (by Industry), USD	This reflects the direct contribution made by an industry in producing a good or service for export.
EXGR_IDC	Indirect Domestic Value-Added (by Industry), USD.	This reflects the indirect contribution of domestic supplier industries made through domestic (upstream) transactions.
EXGR_RIM	Re-imported Domestic Value-Added (by Industry), USD	This reflects the domestic value-added that was exported in goods and services used to produce the intermediate imports of goods and services used by the industry in question.
EXGR_FVA	Foreign Value-Added share of gross exports, by country of origin (USD)	This reflects the foreign value-added embodied in imports broken down by country of origin.
EXGR_DDCSH	EXGR_DDC as a % of EXGR (by Industry).	The share reflects how much value-added is generated in an industry per unit of its total gross exports.
EXGR_IDCSH	EXGR_IDC as a % of EXGR (by Industry).	The share reflects the value-added created in upstream industries providing domestic inputs to the exporting industry.
EXGR_RIMSH	EXGR_RIM as a % of EXGR (by Industry).	The share reflects the value-added created in upstream domestic industries providing indirect intermediate inputs, via international, as opposed to domestic, value-chains to the industry in question. The indicator provides a measure of how protectionist measures may impact on domestic industries that provide inputs to imports.
EXGR_FVASH	EXGR_FVA as a % of EXGR (by Industry).	This is equivalent to 1 minus EXGRDVA_EX

Intermediate Imports

Variable Name	Variable Description	Comments
REI	Intermediate Imports embodied in Exports, as a per cent of total intermediate imports, (by Industry, %).	This reflects the share of intermediate imports that are used (indirectly and directly) in producing goods and services for export, as a per cent of total intermediate imports (by import category). The indicator provides a measure of the importance of intermediate imports to produce goods and services for export and their role as a source of international competiveness.

Value-Added embodied in Final Domestic Demand

Variable Name	Variable Description	Comments
FDDVA	Domestic Value-Added embodied in Foreign Final Domestic Demand, by importing country and exporting industry, USD	Value-Added embodied in Foreign Final Domestic Demand shows how industries export value both through direct final exports and via indirect exports of intermediates through other countries to foreign final consumers (households, charities, government, and as investment). They reflect how industries (upstream in a value-chain) are connected to consumers in other countries, even where no direct trade relationship exists. The indicator illustrates therefore the full upstream impact of final demand in foreign markets to domestic output. It can most readily be interpreted as 'exports of value-added'.
FDDVASH	FDDVA by importing country and exporting industry as a per cent of total FDDVA, %	
FDDVA_GDP	FDDVA as a per cent of GDP, by importing country and exporting industry	
FDFVA	Foreign Value-Added embodied in Final Domestic Demand, by origin country and origin industry, USD	Foreign Value-Added embodied in Final Domestic Demand shows for a final good or service (purchased by households, government, non-profit institutions serving households, or as investment) where foreign value-added originates. It is the 'import' corollary of FDDVA and shows how industries abroad (upstream in a value-chain) are connected to consumers at home, even where no direct trade relationship exists. It can most readily be interpreted as 'imports of value-added'
FDFVASH	FDDVA by origin country and origin industry as a per cent of total FDDVA, %	
FDFVA_GDP	FDDVA as a per cent of GDP, by origin country and origin industry	
TSVAFD	Bilateral Trade balances in value-added by Partner Country (FDDVA minus FDFVA), USD	The bilateral trade position in value-added terms.
TSVAFD_GDP	Bilateral Trade balances in value-added by Partner Country (FDDVA minus FDFVA), % GDP	

Services

Variable Name	Variable Description	Comments
SERV_VAGR	Total Domestic Value-Added of the services sector (only) embodied in gross exports (by Industry), % of total exports.	This reflects the services domestic value-added embodied in exports as a per cent of exports. It provides a simple measure that illustrates the real underlying contribution made by services to exports and can be broken down into three components, described below as EXGR_DDC_SV, EXGR_IDC_SV and EXGR_RIM_SV.
EXGR_DDC_SV	Direct Services Value-Added (by Industry), USD	This reflects the direct services value-added made by an industry in producing a good or service for export. By definition it will be zero for all non-services industries.
EXGR_IDC_SV	Indirect Domestic Services Value-Added (by Industry), USD.	This reflects the indirect contribution of domestic service suppliers made through domestic (upstream) transactions, for exports.
EXGR_RIM_SV	Re-imported Services Domestic Value-Added (by Industry), USD	This reflects the domestic services value-added that was exported in goods and services used to produce the intermediate imports of goods and services used by the industry in question.
EXGR_FVA_SV	Foreign Services Value-Added share of gross exports, by country of origin (USD)	This reflects the foreign services value-added embodied in imports broken down by country of origin.

SERV_VAFD	Domestic Services Value-Added embodied in Foreign Final Domestic Demand, by origin country and origin industry, as % of total final demand in the importing country

The following provides an algebraic description of each of the indicators described above:

Gross exports:

Country c's gross exports for a given industry i can be directly calculated from the underlying global IO table by summing up exports in intermediate goods and services and exports in final demand.

$$\mathrm{EXGR}_{c,i} = \sum_{p} \mathrm{EXGR}_{c,p,i} = \sum_{p} (\mathrm{EXGRI}_{c,p,i} + \mathrm{EXGRF}_{c,p,i})$$

$\mathrm{EXGRI}_{c,p,i}$ represents gross exports in intermediates from domestic industry i in country c to p. $\mathrm{EXGRF}_{c,p,i}$ is gross exports in final demand, where c and p $\in$[1,..,N] and c $\neq$ p.

Gross exports as a % of GDP (total value added):

Final demand in OECD's ICIO framework has been benchmarked with each country's GDP from its National Accounts.

$$\mathrm{EXGR\_GDP}_{c,i} = \frac{\mathrm{EXGR}_{c,i}}{\mathrm{GDP}_c}$$

Gross imports:

$\mathrm{IMGRI}_{c,p,i}$ is gross imports in intermediates from country c to p in a given industry i; and $\mathrm{IMGRF}_{c,p,i}$ is gross imports in final demand. Total imports of country c are measured as:

$$\mathrm{IMGR}_{c,i} = \sum_{p} \mathrm{IMGR}_{c,p,i} = \sum_{p} (\mathrm{IMGRI}_{c,p,i} + \mathrm{IMGRF}_{c,p,i})$$

Gross imports as a % of GDP (total value added):

$$\mathrm{IMGR\_GDP}_{c,i} = \frac{\mathrm{IMGR}_{c,i}}{\mathrm{GDP}_c}$$

Gross trade surplus:

$$\mathrm{TSGR}_{c,p,i} = \mathrm{EXGR}_{c,p,i} - \mathrm{IMGR}_{c,p,i}$$

Gross trade surplus as a % of GDP (total value added):

$$\mathrm{TSGR\_GDP}_{c,i} = \frac{\mathrm{TSGR}_{c,i}}{\mathrm{GDP}_c}$$

Gross exports by industry can be broken down into domestic and foreign value added contents, where domestic value added content of gross exports can be further split into three components, direct domestic industry value added, indirect domestic value added and re-imports.

Direct domestic industry value added content of gross exports

$$\mathrm{EXGR\_DDC_c} = \mathrm{V_c EXGR_c}$$

Indirect domestic content of gross exports (originating from domestic intermediates)

$$\mathrm{EXGR\_IDC_c} = \mathrm{V_c}(\mathrm{I} - \mathrm{A_c})^{-1}\mathrm{EXGR_c} - \mathrm{EXGR\_DDC_c}$$

Re-imported domestic value added content of gross exports

$$\mathrm{EXGR\_RIM_c} = \mathrm{V_c B_{c,c} EXGR_c} - \mathrm{EXGR\_DDC_c} - \mathrm{EXGR\_IDC_c}$$

Foreign value added content of gross exports

$$\mathrm{EXGR\_ICE_{c,p}} = \mathrm{V_p B_{p,c} EXGR_{c,p}}$$

Where $\mathrm{EXGR\_DDC_c}$, $\mathrm{EXGR\_IDC_c}$, $\mathrm{EXGR\_RIM_c}$ and $\mathrm{EXGR\_ICE_{c,p}}$ are K x 1 vectors and K represents the total number of industries.

$\mathrm{V_c} = \begin{bmatrix} \mathrm{v_{c1}} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \mathrm{v_{cK}} \end{bmatrix}$ is a K x K matrix with domestic value added shares of each industry i in country c on the diagonal.

$\mathrm{EXGR_{c,p}}$ is a K x 1 vector of gross exports from country c to country p for any given industry i, where $c \neq p$. $\mathrm{EXGR_c}$ is total exports of country c.

$\mathrm{A_c}$ is the IO coefficient matrix from country c's national IO table and $(\mathrm{I} - \mathrm{A_c})^{-1}$ is the corresponding Leontief inverse.

$\mathrm{B} = (1 - \mathrm{A})^{-1}$, is the global Leontief inverse matrix with NK x NK dimensions, and A is the corresponding global IO coefficient matrix. $\mathrm{B_{c,c}}$ is a K x K diagonal block matrix of B, and it represents the total requirements in gross output for one unit increase of country c's final domestic demand. $\mathrm{B_{p,c}}$ is also a K x K block matrix, and it represents total requirements in gross output from country p for a one unit increase in country c's final demand.

The four components of gross exports are also presented as a share of total gross exports.

Direct domestic industry value added share of gross exports

$$\mathrm{EXGR\_DDCSH_{c,i}} = \frac{\mathrm{EXGR\_DDC_{c,i}}}{\mathrm{EXGR_{c,i}}} \times 100$$

Indirect domestic share of gross exports (originating from domestic intermediates)

$$\mathrm{EXGR\_IDCSH}_{c,i} = \frac{\mathrm{EXGR\_IDC}_{c,i}}{\mathrm{EXGR}_{c,i}} \times 100$$

Re-imported domestic value added share of gross exports

$$\mathrm{EXGR\_RIMSH}_{c,i} = \frac{\mathrm{EXGR\_RIM}_{c,i}}{\mathrm{EXGR}_{c,i}} \times 100$$

Foreign value added share of gross exports

$$\mathrm{EXGR\_ICESH}_{c,i} = \frac{\sum_p \mathrm{EXGR\_ICE}_{c,p,i}}{\mathrm{EXGR}_{c,i}} \times 100$$

$\mathrm{EXGR\_DDC}_{c,i}$ is the i-th element of the Kx1 vector $\mathrm{EXGR\_DDC}_c$, and gives direct domestic value added context of gross export of a given industry i. The same rule applies to indirect domestic value added and re-import shares of gross exports. Foreign value added shares of gross exports are summed for all partners in the current database (16 January 2013).

Domestic value added embodied in gross exports:

$$\mathrm{EXGRDVA}_c = \sum_p \mathrm{EXGRDVA}_{c,p} = \sum_p V_c B_{c,c} \mathrm{EXGR}_{c,p}$$

Foreign value added embodied in gross imports:

$$\mathrm{IMGRFVA}_c = \sum_p \mathrm{IMGRFVA}_{c,p} = \sum_c V_c B_{c,c} \mathrm{EXGR}_{p,c}$$

$\mathrm{EXGRDVA}_{c,p}$ and $\mathrm{IMGRDVA}_{c,p}$ are both K x 1 vectors, representing country c's domestic value added embodied in gross exports to country p and country p's value added embodied in country c's imports respectively, for any given industry i. Both variables are aggregated for all partners in the current database.

Domestic value added embodied in foreign final demand

$$\mathrm{FDDVA}_{c,p} = V_c \sum_s B_{c,s} \mathrm{EXGRF}_{s,p}$$

$\mathrm{FDDVA}_{c,p}$ and $\mathrm{EXGRF}_{s,p}$ are K x 1 vectors. $\mathrm{EXGRF}_{s,p}$ representing final demand produced in country s that is finally consumed in partner country p . $B_{c,s}$ is the off diagonal block matrix of global Leontief inverse matrix B, first defined as in category B. When s = p, $\mathrm{EXGRF}_{p,p}$ is final demand in country p.

Domestic value added embodied in foreign final demand – partner shares, % of total domestic value added embodied in foreign final demand

$$\mathrm{FDDVASH}_{c,p,i} = \frac{\mathrm{FDDVA}_{c,p,i}}{\sum_p \mathrm{FDDVA}_{c,p,i}} \times 100$$

$\mathrm{FDDVA}_{c,p,i}$ is the i-th element of the K x 1 vector $\mathrm{FDDVA}_{c,p}$.

Domestic value added embodied in foreign final demand as a % of GDP (total value added)

$$\mathrm{FDDVA\_GDP}_{c,p,i} = \frac{\mathrm{FDDVA}_{c,p,i}}{\mathrm{GDP}_c} \times 100$$

Foreign value added embodied in domestic final demand

$$\mathrm{FDFVA}_{c,p} = \mathrm{V}_p \sum_s \mathrm{B}_{p,s} \mathrm{EXGRF}_{s,c}$$

$\mathrm{FDFVA}_{c,p}$ and $\mathrm{EXGRF}_{s,c}$ are K x 1 vectors. $\mathrm{EXGRF}_{s,c}$ represents final demand produced in s that is finally consumed in c.

Foreign value added embodied in domestic final demand – partner shares, % of total foreign value added in domestic final demand

$$\mathrm{FDFVASH}_{c,p,i} = \frac{\mathrm{FDFVA}_{c,p,i}}{\sum_p \mathrm{FDFVA}_{c,p,i}} \times 100$$

$\mathrm{FDFVA}_{c,p,i}$ is the i-th element of the K x 1 vector $\mathrm{FDFVA}_{c,p}$.

Foreign value added embodied in domestic final demand as a % of GDP (total value added)

$$\mathrm{FDFVA\_GDP}_{c,p,i} = \frac{\mathrm{FDFVA}_{c,p,i}}{\mathrm{GDP}_c} \times 100$$

Value added in final demand, surplus

$$\mathrm{TSVAFD}_{c,p,i} = \mathrm{FDDVA}_{c,p,i} - \mathrm{FDFVA}_{c,p,i}$$

Value added in final demand, surplus as a % of GDP (total value added)

$$\mathrm{TSVAFD\_GDP}_{c,p,i} = \frac{\mathrm{TSVAFD}_{c,p,i}}{\mathrm{GDP}_c} \times 100$$

Difference in trade surpluses (value added in final demand minus gross trade)

$$\mathrm{TSVAFD\_TSGR}_{c,p} = \sum_i \mathrm{TSVAFD}_{c,p,i} - \left(\sum_i \mathrm{EXGR}_{c,p,i} - \sum_i \mathrm{IMGR}_{c,p,i}\right)$$

Direct domestic service industry value added content of gross exports

$$\mathrm{EXGR\_DDC\_SV}_{c,i} = V_{c,j}\mathrm{EXGR}_{c,i}$$

Indirect domestic services content of gross exports (originating from domestic intermediates)

$$\mathrm{EXGR\_IDC\_SV}_{c,i} = \sum_{j\in S} V_{c,j}(I - A_c)^{-1}{}_{ji}\mathrm{EXGR}_{c,i} - \mathrm{EXGR\_DDC\_SV}_{c,i}$$

Re-imported domestic services value added content of gross exports

$$\mathrm{EXGR\_RIM\_SV}_{c,i} = \sum_{j\in S} V_{c,j}\left(B_{c,c}\right)_{ji}\mathrm{EXGR}_{c,i} - \mathrm{EXGR\_DDC\_SV}_{c,i} - \mathrm{EXGR\_IDC\_SV}_{c,i}$$

Foreign services value added content of gross exports

$$\mathrm{EXGR\_ICE\_SV}_{c,i} = \sum_{p}\sum_{j\in S} V_{p,j}\left(B_{p,c}\right)_{ji}\mathrm{EXGR}_{c,p,i}$$

$\mathrm{EXGR\_DDC\_SV}_{c,i}$ represents the direct domestic service industry value added content of country c's gross exports in industry i. $\mathrm{EXGR\_IDC\_SV}_{c,i}$, $\mathrm{EXGR\_RIM\_SV}_{c,i}$ and $\mathrm{EXGR\_ICE\_SV}_{c,i}$ are defined similarly.

$V_{c,j}$ is value added share of service industry j in home country c, where $j \in S$; otherwise, $V_{c,j} = 0$.

$(I - A_c)^{-1}{}_{ji}$ is the ji-th element of local Leontief inverse matrix.

$\left(B_{c,c}\right)_{ji}$ and $\left(B_{p,c}\right)_{ji}$ are the ji-th element of $B_{c,c}$ and $B_{p,c}$ respectively.

Services value added embodied in gross exports by source country, as % of gross exports

$$\mathrm{SERV\_VAGR}_{c,p,i} = \sum_{j\in S} V_{p,j}\left(B_{p,c}\right)_{ji}\mathrm{EXGR}_{c,p,i}/\mathrm{EXGR}_{c,p,i}$$

$\mathrm{SERV\_VAGR}_{c,p,i}$ represents the share of services value added in gross export of country c that sourced from partner country p for any given sector i.

Services value added embodied in foreign final demand , as % of foreign final demand

$$\mathrm{SERV\_VAFD}_{c,p,i} = \sum_{j\in S} V_{p,j}\left(B_{p,c}\right)_{ji}\mathrm{EXGRF}_{c,p,i}/\mathrm{EXGRF}_{c,p,i}$$

$\mathrm{SERV\_VAFD}_{c,p,i}$ represents the share of services value added in export in final demand of country c that sourced from partner country p for any given sector i.

Re-exported intermediates as a % of total intermediate imports

$$\mathrm{REI}_{c,i} = \left(\sum\nolimits_{p} \mathrm{A}_{p,c}\mathrm{B}_{c,c}\mathrm{EXGR}_{c}\right)_{i} / \left(\sum\nolimits_{p} \mathrm{IMGRI}_{c,p}\right)_{i}$$

$\mathrm{A}_{p,c}$ is the K x K IO coefficient matrix, giving c's requirements in imported intermediate products sourced from country p.

$\mathrm{A}_{p,c}\mathrm{B}_{c,c}\mathrm{EXGR}_{c}$ is also a K x 1 vector and refers to intermediate goods and services absorbed in country c that originated from p for c' total exports. $\left(\sum_{p} \mathrm{A}_{p,c}\mathrm{B}_{c,c}\mathrm{EXGR}_{c}\right)_{i}$ refers to the i-th element of the vector and gives total intermediate goods and services absorbed by country c that originated from foreign countries in industry i.

$\left(\sum_{p} \mathrm{IMGRI}_{c,p}\right)_{i}$ is the i-th element of the K x 1 vector with aggregated intermediate imports of country c for each industry I, where $\mathrm{IMGRI}_{c,p}$ is a vector giving c's intermediate imports from P for each industry.

Value added export ratio total domestic value added share of gross exports, %

$$\mathrm{EXGRDVA\_EX}_{c,i} = \frac{\mathrm{EXGRDVA}_{c,i}}{\mathrm{EXGR}_{c,i}} \times 100$$

Value added export ratio total domestic value added in foreign final demand as % of gross exports

$$\mathrm{FDDVA\_EX}_{c,p} = \frac{\sum_{i} \mathrm{FDDVA}_{c,p,i}}{\sum_{i} \mathrm{EXGR}_{c,p,i}} \times 100$$

Revealed comparative advantage based on gross exports, manufacturing goods

$$\mathrm{RCA\_EXGR}_{c,i} = \frac{\sum_{p} \mathrm{EXGR}_{c,p,i} / \sum_{p,i} \mathrm{EXGR}_{c,p,i}}{\sum_{c,p} \mathrm{EXGR}_{c,p,i} / \sum_{c,p,i} \mathrm{EXGR}_{c,p,i}}$$

Revealed comparative advantage based on domestic value added embodied in gross exports, manufacturing goods

$$\mathrm{RCA\_EXGRDVA}_{c,i} = \frac{\sum_{p} \mathrm{EXGRDVA}_{c,p,i} / \sum_{p,i} \mathrm{EXGRDVA}_{c,p,i}}{\sum_{c,p} \mathrm{EXGRDVA}_{c,p,i} / \sum_{c,p,i} \mathrm{EXGRDVA}_{c,p,i}}$$

Where i is restricted to manufacturing sectors only.

$\mathrm{EXGRDVA}_{c,p,i}$ is the i-th element of $\mathrm{EXGRDVA}_{c,p}$.

REFERENCES

Ahmad, N and A.Wyckoff (2003). "Carbon Dioxide Emissions Embodied in International Trade of Goods," OECD Science, Technology and Industry Working Papers 2003/15

Ahmad, N and S. Araujo (2011). “Measuring Trade in Value-Added and Income using Firm-Level data”.

Ahmad, N, S. Araujo, A. Lo Turco and D.Maggioni (2013). " Using Trade microdata to improve Trade in Value-Added measures: Proof of concept using Turkish data"

Ahmad, N, Z.Wang and N.Yamano, (2013). "A Three Stage Reconciliation Method to Construct Time Series International Input-output Database"

Ali-Yrkkö, J., P. Rouvinen, T. Seppälä and P. Ylä-Anttila (2011). “Who captures value in global supply chains? Case Nokia N95 Smartphone, ETLA Discussion Papers No. 1240, February.

Daudin, G., C. Rifflart and D. Schweisguth (2009). “Who produces for whom in the world economy?”, Document de travail de l’OFCE N° 2009-18, July.

Dedrick, J., K.L. Kraemer and G. Linden (2010). “Who profits from innovation in global value chains?: a study of the iPod and notebook PCs”, *Industrial and Corporate Change* 19(1), 81-116.

Escaith, H. (2008). « Nouvelle économie industrielle, commerce international et valeur ajoutée: implications statistiques et comptables », Actes du 12e colloque de l’Association de comptabilité nationale, INSEE-Méthodes, 225-251.

Escaith, H., N. Lindenberg and S. Miroudot (2010). “International supply chains and trade elasticity in time of global crisis”, WTO Staff Working Paper ERSD-2010-08.

Escaith, H, A.Keck, C. Nee and R.Teh (2011), "Japan's earthquake and tsunami: International trade and global supply chain impacts", VoxEU, 28 April.

Johnson, R.C. and G. Noguera (2011). “Accounting for intermediates: Production sharing and trade in value added”, *Journal of International Economics*, forthcoming.

Jones, R. and H. Kierzkowski (2001). “A framework for fragmentation”. In: S. Arndt and H. Kierzkowski (eds), *Fragmentation: New Production Patterns in the World Economy*, New York: Oxford University Press, 17-34.

Hayakawa, K. (2007). “Growth of intermediate goods trade in East Asia”, *Pacific Economic Review* 12(4), 511-523.

Koopman, R., Z. Wang and S.-J. Wei (2008). “How much Chinese exports is really made in China – Assessing foreign and domestic value-added in gross exports”, NBER Working Paper No. 14109.

Koopman, R., W. Powers, Z. Wang and S.-J. Wei (2011). “Give credit to where credit is due: tracing value added in global production chains”, NBER Working Papers Series 16426, September 2010, revised September 2011.

Lanz, R., Miroudot, s. and A. Ragoussis (2009). “Trade in intermediate goods and services”, OECD Trade Policy Working Paper No. 93, OECD.

Lee, H.L., V. Padmanabhan and S. Whang (1997). “The bullwhip effect in supply chains”, *Sloan Management Review*, 38(3), 93-102.

Leontief, W. and A. Strout (1963). “Multiregional Input-Output Analysis”. In: T. Barna (ed.), *Structural Interdependence and Economic Development*, New York: St-Martin’s Press, 119-150.

Linden, G., K. L. Kraemer and J. Dedrick (2009). “Who captures value in a global innovation network? The case of Apple’s iPod”, *Communications of the ACM* 52(3), 140-144.

Linden, G., K. L. Kraemer and J. Dedrick (2011). “Who captures value in the Apple iPad?”, mimeo, March.

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

Meng, B., N. Yamano and C. Webb (2010). “Application of factor decomposition techniques to vertical specialisation measurements”, IDE Discussion Paper No. 276, Institute of Developing Economies.

Miroudot, S., R.Lanz, R., A.Ragoussis. (2009). Trade in intermediate goods and services. OECD Trade Policy Working Paper 93, OECD.

Nakano, S., A. Okamura, N. Sakurai, M. Suzuki, T. Tojo and N. Yamano (2009). “The measurement of CO2 embodiments in international trade. Evidence from harmonised input-output and bilateral trade database”, OECD Science, Technology and Industry Working Papers 2009/3.

Parikh, A. (1979). “Forecasts of Input-Output Tables using the RAS Method”, *Review of Economics and Statistics* 61 (3), 477-481.

Sanyal, K. and R. Jones (1982). “The theory of trade in middle products”, *American Economic Review* 72(1), 16-31.

Walmsley, T. L. and C. Lakatos (2008). “Regional input-output data”. In: *Global Trade, Assistance, and Production: The GTAP 7 Data Base, B*. Narayanan and T.L. Walmsley (eds), Center for Global Trade Analysis, Purdue University.

WTO and Commission des Finances du Sénat (2011). *Conference proceedings 'Globalization of industrial production chains and measurement of trade in value added'*, Geneva.

WTO and IDE-JETRO (2011). *Trade Patterns and Global Value Chains in East Asia: From trade in goods to trade in tasks*, Geneva.

Xing, Y. and N. Detert (2010). “How the iPhone widens the United States trade deficit with the People’s Republic of China”, ADBI Working Paper Series No. 257, December.

Yang, C. (2013, forthcoming). "Measurement of International Trade in Value-Added: using Chinese input-output tables capturing processing trade"