Chapter 2

Measuring trade in value added

The increasing international fragmentation of production that has occurred in recent decades has challenged the conventional perception and interpretation of trade. Traditional measures of trade record gross flows of goods and services every time they cross borders. In a world characterised by global value chains (GVCs), this leads to what many describe as "multiple" counting of trade, which may in turn lead to misguided policy measures. The OECD-WTO estimates of trade in value added (TiVA) can better interpret trade in a world of GVCs. The TiVA Database can also act as an impetus for the production of national statistics that better reflect global interdependencies.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

What is trade in value added?

Global value chains (GVCs) are a dominant feature of today's global economy. The growing international fragmentation of production challenges the conventional perception and interpretation of trade statistics and, in particular, the policies that we develop around them. Because traditional measures of trade record gross flows of goods and services every time they cross borders, they may lead to misguided policy decisions.

Various studies that focus on the production process of an individual product have been used to shed light on this issue and are widely referred to throughout this publication. Perhaps the best-known example is that of the Apple iPod (Linden et al., 2009), which showed that of the iPod's USD 144 (Chinese) factory-gate price, less than 10% represented Chinese value added. The bulk of the components (about USD 100 in value added) were imported from Japan and much of the rest came from the United States and Korea (see Chapter 1).

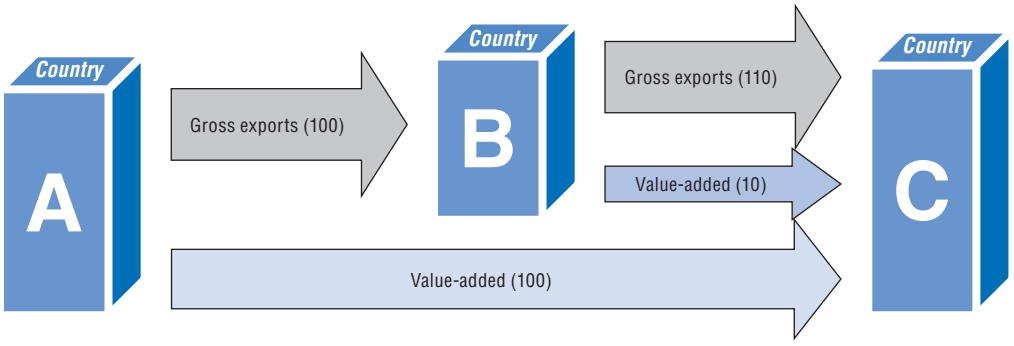
However this stylised approach, frequently referred to as 'screwdriver' economics (see Chapter 1), can generally only be used for specific products and, even then, it only reveals part of the story about who benefits from trade and how global value chains work. Typically it is only possible to show where the various intermediate components were produced, but not how and where the intermediate parts were themselves created, and how the intermediate parts used to produce those intermediate parts were produced, and so on. For example, in the iPod example, the message would be significantly different if the parts imported from Japan to make the iPod themselves required significant Chinese content.

To deal with the bigger picture and understand total economy effects and capture all of the upstream effects, several studies have adopted a macro approach, based on the construction of inter-country or world input-output (I-O) tables (Hummels et al., 2001; Daudin et al., 2009; Johnson and Noguera, 2012; and Koopman et al., 2011). A number of pioneering initiatives by GTAP (the Global Trade Analysis Project), the World Trade Organization (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 single efforts and have often required the use of unofficial statistical data. What was lacking was a systematic attempt to mainstream the development of statistics in this area. In response, in March 2012, the OECD and WTO joined forces to develop a database of indicators based on trade in value added (TiVA Database). The first results were released in January 2013.

The Trade in Value Added initiative addresses the double counting implicit in current gross trade flows, as intermediate goods and service cross borders many times (and do so increasingly with the rise of GVCs). Instead it 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.

Figure 2.1. A simple schematic for trade in value added



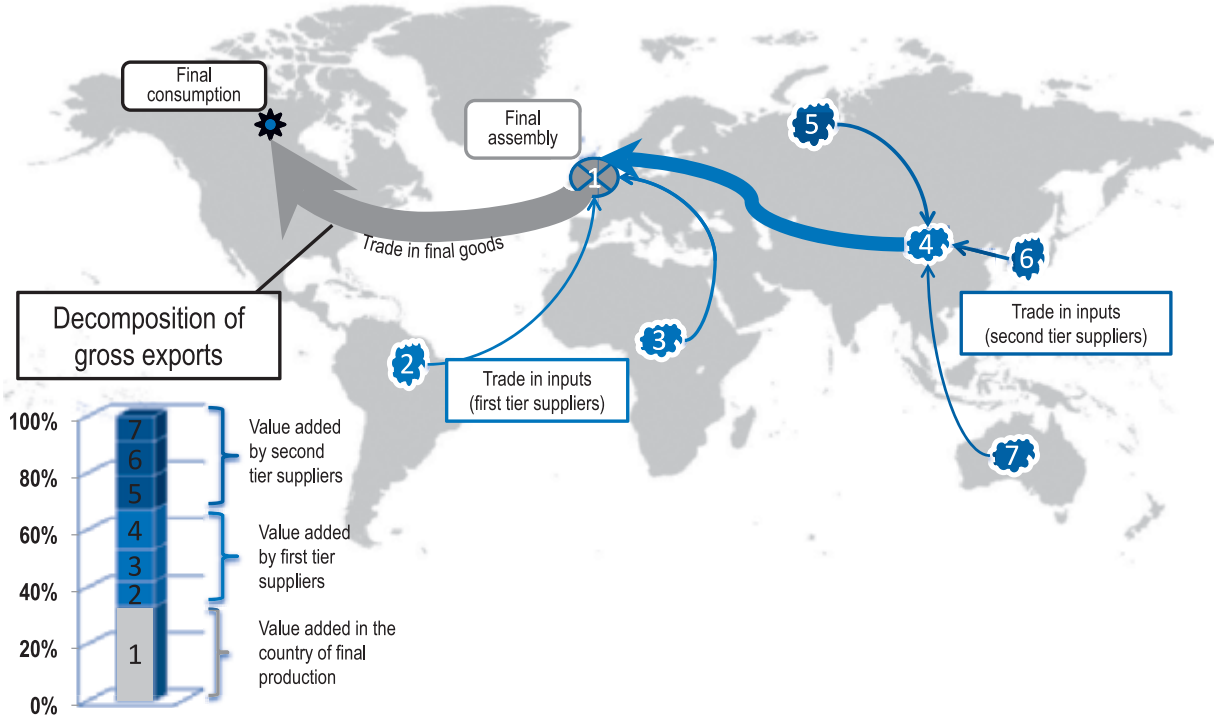
Source: OECD (2012).

The simple example in Figure 2.1 illustrates this. Country A exports USD 100 of goods, produced entirely in A, to country B, which further processes them before exporting them to C where they are consumed. B adds value of USD 10 to the goods and so exports USD 110 to C. Conventional measures of trade show total global exports and imports of USD 210 but only USD 110 of value-added has been generated in their production. Conventional measures also show that C has a trade deficit of USD 110 with B, and no trade at all with A, despite the fact that A is the chief beneficiary of C's consumption.

By tracking flows of 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. This reduces its deficit with B to USD 10. If the same approach is applied to A's value added, C will have a deficit of USD 100 with A. C's overall trade deficit with the world remains at USD 110. What has changed is its bilateral positions. This simple illustration reveals how output in one country may be affected by consumers in another and by how much (for example C's consumers drive A's output) but it also offers 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 may harm its exporters and hence its competitiveness. By providing information at the level of specific industries, it is possible to provide insights into other areas as well, such as the actual contribution of the services sector to international trade, as discussed in Chapter 3.

Figure 2.2 expands on this exposition to consider producers further upstream in global value chains. The figure shows that conventional trade statistics would record gross exports from Europe (1) to North America, gross exports from the Russian Federation (5), Japan (6), and Australia (7) to China (4), and gross exports from China, South America (2) and Africa (3) to Europe. But these flows only tell part of the story and only partly reflect the nature of global interdependencies. From the perspective of North America, the only interactions are with Europe, yet it is demand from North American consumers that drives the output throughout this global value chain. The aim of the trade in value added approach is therefore to identify the nature of these inter-relationships by breaking the value of a given gross export down into its value-added components (by country of origin and industry). A number of indicators follow from this underlying principle, as will be seen below. One simple but important indicator, for example, reallocates gross trade flows across countries on the basis of who finally consumes the underlying value-added embodied in the (gross) export and the origin of each piece of value added, thereby creating bilateral links between consumers and all upstream producers.

Figure 2.2. A simple global value chain



Source: OECD (2012). *Map source:* © ARTICQUE – all rights reserved.

Why measuring trade in value added is important

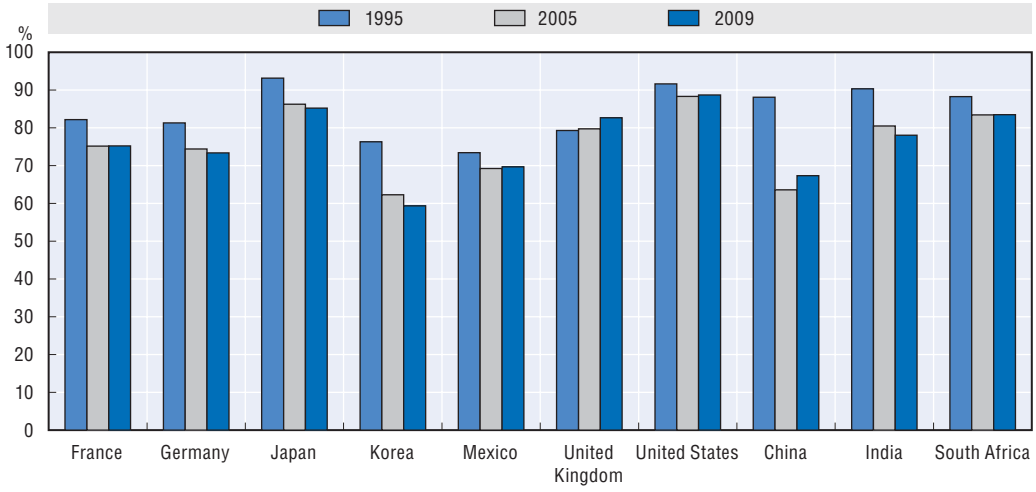
The need for better policy evidence

Policy makers seek better policy evidence to learn if, and to what extent, (national) policies need to change as a result of GVCs. Later chapters use the new results on trade in value added to discuss the impacts of GVCs on a wide range of policy domains.

Understanding how much domestic value added is created by the export of a good or service is crucial for understanding how trade contributes to the economic growth and competitiveness of countries. Some economies have capitalised on global value chains by developing comparative advantages in specific parts of the value chain. For example, much of the People's Republic of China's exports currently involves assembly work with a high level of foreign content, leading to a significant fall in its domestic value added to output ratio between 2005 and 2009. But data for recent years indicate that China may be beginning to move upstream in the value chain Chapter 5). This pattern of increasing international fragmentation of production is not confined to China though (Figure 2.3). The data reveal that access to efficient imports matters as much in a world of international fragmentation as does access to markets. Figure 2.4 reinforces this picture by showing the shares of total intermediate imports that are eventually used to produce goods and services for export.

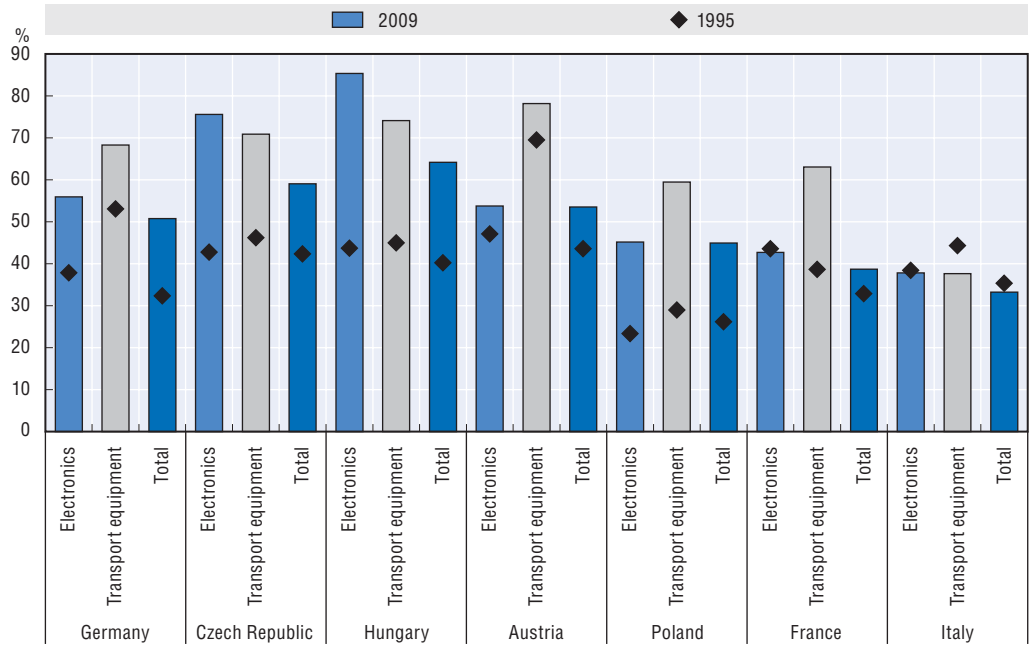
In most economies, significant shares of intermediate imports are destined for the export market. Within the European production hub shares are around 50% for many economies. In Hungary, nearly two-thirds of all intermediate imports are destined for the export market after further processing, with the share reaching 85% for electronic intermediate imports. Similar patterns exist in Factory Asia and in NAFTA.

Figure 2.3. Domestic content of exports (domestic value added in exports, % of total gross exports), 1995-2009



Source: OECD/WTO (2013), OECD-WTO: Statistics on Trade in Value Added, (database), doi: 10.1787/data-00648-en (accessed April 2013).

Figure 2.4. Intermediate imports embodied in exports, % of total intermediate imports, 1995 and 2009



Source: OECD/WTO (2013), OECD-WTO: Statistics on Trade in Value Added, (database), doi: 10.1787/data-00648-en (accessed April 2013).

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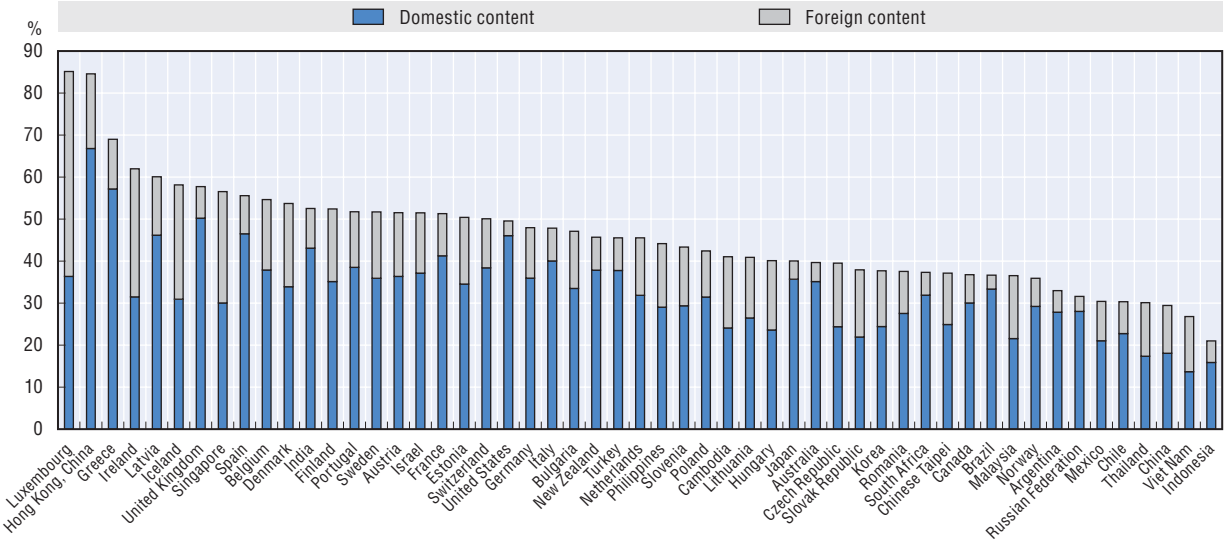
In addition, domestic value added is found not only in exports but also in imports: goods and services produced in one domestic industry may be shipped abroad as intermediates but come back to the domestic economy embodied in the imports of other, and often the same, industries (see Chapter 3). As a consequence, tariffs, non-tariff barriers and trade measures 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.

In the United States for example about 5% of the total value of imported intermediates reflects US value added. Moreover, these are prudent estimates. As discussed below, the estimates currently produced under the OECD-WTO TiVA initiative rely on a number of prudent assumptions, so that current estimates of the foreign content of exports, and of returned value added, are likely to be conservative (biased downwards). The United States, for example, exports significant quantities of goods for further processing to Mexico. Better reflecting these flows, and, in particular, better estimating the foreign content of Mexico's exports is likely to increase the US value-added shares of its imports significantly. The OECD is working with national statistics offices to motivate the provision and compilation of data that will improve the quality of the TiVA results and reduce the impact of these prudent assumptions.

Looking at trade from a value-added perspective helps to illustrate how upstream domestic industries contribute to exports, even if they have little direct international exposure. Services comprise about two-thirds of GDP in most developed economies, but gross trade statistics show that less than one-quarter of total global trade is in services. This partly reflects the fact that significant shares of services output are generally not tradable for example 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 services sector provides significant intermediate inputs to domestic goods manufacturers.

Figure 2.5. Services value added, % of total exports, 2009



Note: 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.

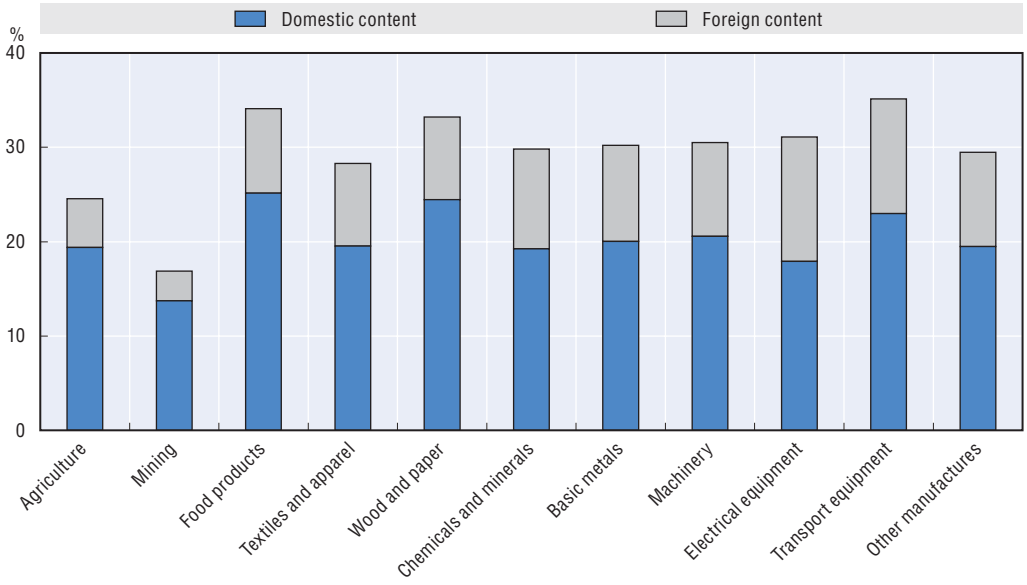
Source: OECD/WTO (2013), OECD-WTO: Statistics on Trade in Value Added, (database), doi: 10.1787/data-00648-en (accessed April 2013).

StatLink http://dx.doi.org/10.1787/888932834492

Accounting for the value added produced by the services sector in the production of goods shows that the services content of total gross exports is over 50% in most OECD economies and approaches 60% in the United Kingdom (Figure 2.5 and Chapter 3). Canada, with significant exports of natural resources, which typically have low services content, has the lowest services content of exports in the G7 but even there the share is close to 40%. Typically, emerging economies and other large exporters of natural assets, such as Australia, Chile, and Norway, have the lowest shares of services. But in India over half of the value of its gross exports originates in the services sector.

Goods industries require significant intermediate inputs of services from both foreign and domestic suppliers (Figure 2.6). Looking at trade in value-added terms can reveal that policies to encourage services trade liberalisation and more foreign direct investment, and therefore access to more efficient services, can improve the export competitiveness of goods industries.

Figure 2.6. Services value added, % of total exports of goods, 2009 (OECD + BRIICS)



Note: BRIICS: Brazil, Russian Federation, India, Indonesia, China, South Africa.

Source: OECD/WTO (2013), OECD-WTO: Statistics on Trade in Value Added, (database), doi: 10.1787/data-00648-en (accessed April 2013).

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The discussion of trade imbalances therefore changes when trade in value added (specifically trade in intermediate parts and components) and "trade in tasks" are taken into account. While a country's overall trade balance with the rest of the world does not change, the surpluses and deficits with partner countries are redistributed. In gross terms, the deficit with producers of final goods (or the surplus of exporters of final products) is exaggerated because it incorporates the value of foreign inputs. However, the underlying imbalance is in fact, at least partly, with the countries that supply inputs to the final producer. As pressures for rebalancing increase in the context of persistent deficits, there is a risk of protectionist responses directed at countries at the end of global value chains because of an inaccurate perception of the origin of trade imbalances, as shown for China in Figure 2.7.

Figure 2.7. China's value-added and gross trade balances, USD billion, 2009

Source: OECD/WTO (2013), OECD-WTO: Statistics on Trade in Value Added, (database), doi: 10.1787/data-00648-en (accessed April 2013).

StatLink http://dx.doi.org/10.1787/888932834530

In 2009, for example, China's bilateral trade surplus with the United States was over USD 60 billion (one-third) less in value-added terms. This partly reflects the higher share of US value-added imports in Chinese final demand but also the fact that one-third of China's exports contain foreign content – the "Factory Asia" phenomenon. Because significant exports of value added from Korea and Japan pass through China on their way to final consumers, China has significantly smaller trade deficits with these countries but Japan and Korea also have typically higher trade surpluses with other countries. Similarly, the data show that Korea's significant trade deficit with Japan falls in value-added terms.

Trade in value added gives policy makers a better view of the impact of macroeconomic shocks on trade. In the 2008-09 financial crisis, trade collapsed simultaneously in all economies, and the role of global supply chains in the transmission of what was initially a demand shock in markets affected by a credit shortage has been discussed (see Chapter 8). Better understanding of value-added trade flows would help policy makers to anticipate the impact of macroeconomic shocks and adopt appropriate policy responses. An analysis of the impact of trade on short-term demand that is based on gross trade flows is likely to be strongly biased.

The database shows gradual increases in the domestic content of exports around the time of the financial crisis, providing some indication of how global value chains were affected by the unprecedented slowdown in global trade. Clearly, the more the production of a good or service is fragmented, the more likely it was to be affected by the synchronised slowdown in trade and demand that characterised the crisis.

Several studies of the impact of trade liberalisation on labour markets have attempted to estimate the "job content" of trade. Estimates of trade in value added can also help to clarify the link between trade and employment in more detail and to show where jobs are being created. A breakdown of the contribution of each economy, including the domestic economy, to the value of exports can help. Traditional thinking about trade in gross terms typically regards imports as jobs lost and transferred to the countries in which the imports originate. In value-added terms, a different picture emerges. For example, workers may

lose jobs at the assembly stage, but measures based on value added would show where jobs are created as a result of value added (in marketing, design, development, etc.). When comparative advantages apply to "tasks" rather than to "final products", the skill composition of labour embodied in the domestic content of exports reflects the relative level of development of participating countries. Industrialised countries therefore tend to specialise in high-skill tasks such as research and development (R&D), design and marketing, which are better paid and capture a larger share of the total value added.

Another area in which the measurement of trade flows in value-added terms would support policy making is assessments of the environmental impact of trade. Concerns over greenhouse gas emissions and their potential role in climate change have triggered research on how trade openness affects CO_2 emissions. The unbundling of production and consumption and the international fragmentation of production require a value-added view of trade to understand where CO_2 is produced as a consequence of trade. Various OECD studies have found that the relocation of industrial activities can have a significant impact on differences in consumption-based and production-based measures of CO_2 emissions (Ahmad and Wyckoff, 2003).

The need for national statistics to (better) reflect global interdependencies

From their early beginnings in the 1920s and 1930s and the pioneering work of Klark and Kuznets and then Stone in the 1940s, national statistics systems have continuously evolved and significantly improved. Examples include the international standards of the 1953, 1968, 1993 and 2008 Systems of National Accounts and the revisions to the Balance of Payments manuals from the first edition in 1948 to the sixth update in 2009.

These international standards, among others, have been instrumental in improving the international comparability of national statistics, but they essentially remain mechanisms for measuring activity within an economy and with direct trading partners. The increasing tendency for firms, particularly multinationals, to participate in global value chains has raised the question of whether the conventional focus on the national perspective in statistical compilation needs to be modified to deal with this new reality.

Although GDP arguably remains the most important economic aggregate for policy makers (even though it is shifting in some countries towards gross national income because of the growing importance of multinationals), the aggregate is useful only because of its components. From the "output" side, this means knowing which industries provide goods and services and generate profits and employment and how, and from the demand side, this means knowing what consumers purchase and from whom.

When goods and services were entirely produced within national borders, with imports and exports typically final goods, conventional statistics were well equipped to respond to policy needs. However, this is increasingly no longer the case. Generally speaking, when producing and analysing statistics for industries, it is implicitly assumed that all firms allocated to a particular classification will behave in much the same way, i.e. that for a given output they will have similar production functions, productivity, procurement patterns, etc. This of course was always something of a convenient fiction, but the increasing international fragmentation of production means that it is probably even more so today.

Today's business environment is increasingly littered with new types of firms (and an associated lexicon, such as fabless[1] producers, processers) which are complicated for the international statistics community. They bring not only a new language but also great diversity and challenge the classification of businesses on the basis of their (main) final product/activity. Moreover, multinational firms, as is demonstrated throughout this publication, clearly organise their activities differently from purely domestic producers, in particular in the way they source inputs (with significant intermediates imported from affiliates abroad).

Global value chains call for a new perspective on statistical compilation. Faced with providing more detailed breakdowns of firms based on their main activity, it is arguably better to begin to look at breakdowns of broader characteristics, such as ownership (foreign-owned or domestic) and the tasks firms engage in, in a more aggregated industry classification, since it is these characteristics that increasingly create heterogeneity.

These are also the characteristics that provide the basis for understanding how firms engage in global value chains. The evidence referred to throughout this report shows that firms participating in global value chains typically have higher foreign content in their production process, and, therefore, different domestic value-added and employment effects, from firms producing goods and services for domestic markets. However, conventional statistics are not able to reflect this. As will be seen below, because national statistics currently fail to capture this heterogeneity, the foreign content estimates produced in this report are likely to be prudent and biased downwards. Dealing with this heterogeneity is important for improving the analytical capacity of national statistics, but also for international statistics and TiVA indicators.

But one need not look so far ahead to make the case for better national statistics. It has long been known that bilateral trade statistics (in gross terms) between trading partners do not always align. One country's recorded exports to another country rarely align with that country's imports (even after accounting for price differences). Indeed, global exports and global imports do not align. Better understanding of global value chains and international interdependencies can help to resolve these long-standing differences, which are even larger when specific products are examined.

As will be seen, the TiVA initiative resolves these differences by using balancing procedures and assumptions, but it has also drawn attention to the need to resolve differences in official national statistics. The TiVA initiative can thus be seen as creating the momentum for a virtuous circle that will provide increasingly better results, by taking better account of the heterogeneity of firms, particularly those that are engaged in global value chains and those that are not, and through extensions such as trade in income (see Annex 2.A2) and better statistics on multinationals.

Estimating trade in value added

As mentioned, several initiatives have addressed the issue of measuring trade flows in the context of the fragmentation of world production.[2] The most commonly used approach is based on global input-output (I-O) tables, using standard Leontief inverses (for more detail, see OECD-WTO, 2012).

National I-O tables describe domestic interactions between domestic industries and between those industries and drivers of final demand (households, not-for-profit institutions serving households, government, investment and exports). They also show who purchases imports, typically broken down by type of import.

Table 2.1 gives a simple example of an I-O table for an economy with two industries. A_{ij} reflects the intermediate consumption in basic prices of industry *j*'s outputs by industry *i*. Table 2.2 shows how each of the entries for imports can also be split into an equivalent industry origin of the imports.

These national tables form the basis of the global I-O table needed to analyse GVCs. In fact, they can be used on their own as the basis of "screwdriver" analyses that drill down one level to show how output in one domestic industry uses inputs from other domestic industries and also imports. What they cannot show is how the intermediate imports used by these industries are produced and what imports they in turn require. In addition national I-O tables cannot be used to illustrate how much of the reporting country's own value added is embodied in its imports. This requires a global I-O table.

Table 2.3 depicts a global table for two countries and two industries in each country, which can be generalised for all countries. In the current OECD global I-O table the breakdown includes data for 57 economies and 37 industries. The rest of the world (R.O.W) is calculated using data on GDP for economies included in R.O.W and total exports and imports of these economies.

The table follows the same notation as in Tables 2.1 and 2.2 except that A^2_{ij} reflects the intermediate consumption of industry *i* in country 2 of products produced by industry *j*. The notation for other entities follows the same logic. All re-exports (XM in Table 2.1) are eliminated from the global I-O table. Domestic final demand is equivalent to total household final consumption, expenditures of non-profit institutions serving households (NPISH), general government final consumption and total investment.

Because all flows are recorded at basic prices there is an additional row, "taxes less subsidies on product", which reflects the taxes paid and subsidies received by industries and final demand consumers on their intermediate and final purchases. For most industries these entries are in practice relatively minor. In most countries this item reflects VAT, which is mainly paid by final demand consumers, as most firms in most industries can reclaim the VAT paid on their purchases, although industries such as financial services and non-market producers also pay VAT on their inputs, as do firms below VAT thresholds. For convenience all flows recorded as value added in the TiVA database allocate these payments to the value-added estimates of the industries.

Table 2.1. A simplified national input-output table

	Industry 1	Industry 2	Households	NPISH	Government	Investment	Exports
Industry 1	A_{11}	A_{12}	H_1	N_1	G_1	In_1	X_1
Industry 2	A_{21}	A_{22}	H_2	N_2	G_2	In_2	X_2
Imports	M_1	M_2	HM	NM	GM	InM	XM
Taxes less subsidies on products	TP_1	TP_2	HTP	NTP	GTP	InTP	XTP
Value-Added at basic prices	V_1	V_2					
of which							
Operating surplus + mixed income	OS_1	OS_2					
Compensation of employees	COE_1	COE_2					
Taxes less subsidies on production	TPr_1	TPr_2					
Output	O_1	O_2					

Table 2.2. A simplified import flow table

	Industry 1	Industry 2	Households	NPISH	Government	Investment	Exports
Industry 1	M_{11}	M_{12}	MH_1	MN_1	MG_1	MIn_1	MX_1
Industry 2	M_{21}	M_{22}	MH_2	MN_2	MG_2	MIn_2	MX_2

Table 2.3. A simplified two-country (global) input-output table

		Country 1		Country 2		Country 1	Country 2
		Industry 1	Industry 2	Industry 1	Industry 2	Domestic Final Demand	Domestic Final Demand
Country 1	Industry 1	A_{11}	A_{12}	M^2_{11}	M^2_{12}	D_1	MD_1
	Industry 2	A_{21}	A_{22}	M^2_{21}	M^2_{22}	D_2	MD_2
Country 2	Industry 1	M_{11}	M_{12}	A^2_{11}	A^2_{12}	MD_1	D^2_1
	Industry 2	M_{21}	M_{22}	A^2_{21}	A^2_{22}	MD_2	D^2_2
Taxes less subsidies on products		TP_1	TP_2	TP^2_1	TP^2_2	DTP	D^2TP
Value-Added at basic prices		V_1	V_2	V^2_1	V^2_2		
Output		O_1	O_2	O^2_1	O^2_2		

Constructing the global table is a data-intensive process and presents many challenges. The main one 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 the data issues faced by the OECD are similar to those confronted by initiatives such as IDE-JETRO (Asian Input-Output Tables) or the World Input Output Database project, with which (as with the US-ITC) the OECD and WTO are actively engaged in order to share experiences and derive a set of best practices.

The OECD data sources are harmonised I-O tables and bilateral trade coefficients in goods and services, derived from official sources.[3] The model specification and estimation procedures can be summarised 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.
- Creation of bilateral trade import matrices:
  - 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 services sectors are based on OECD Trade in Services and UN Service Trade statistics. However, many missing flows are currently estimated using econometric model estimates.
  - Conversion of cost, insurance, freight (c.i.f.) price-based import figures to free on board (f.o.b.) price-based imports to reduce the inconsistency issues of mirror trade data (because of asymmetry in reporting exports and imports in national trade statistics, as described above).
- Adjustment (missing sectors, trade with rest of the world, etc.) and minimisation of discrepancy columns using bi-proportional methods.

National input-output tables

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 ten 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 I-O tables for 57 economies[4] (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, Brunei, Bulgaria, Cambodia, China, Chinese Taipei, Cyprus[5], India, Indonesia, Latvia, Lithuania, Malaysia, Malta, Philippines, Romania, Russian Federation, Saudi Arabia, Singapore, South Africa, Thailand and Viet Nam).

The I-O tables show transactions between domestic industries but, as a complement, supplementary tables that 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 others are derived by the OECD.

Table 2.4. 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 excluding pharmaceuticals
2423	10	Pharmaceuticals
25	11	Rubber and plastics products
26	12	Other non-metallic mineral products
271+2731	13	Iron and steel
272+2732	14	Non-ferrous metals
28	15	Fabricated metal products, except machinery and equipment
29	16	Machinery and equipment, n.e.c.
30	17	Office, accounting and computing machinery
31	18	Electrical machinery and apparatus, n.e.c.
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 and repairing of ships and boats

.../...

Table 2.4. OECD input-output industry classification *(continued)*

ISIC Rev.3 code		Description
353	23	Aircraft and spacecraft
352+359	24	Railroad equipment and transport equipment, n.e.c.
36+37	25	Manufacturing n.e.c. (include Furniture); recycling
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 and 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

The industry classification used in the current version of OECD's I-O database is based on ISIC Rev.3 (Table 2.4). It is therefore compatible with other industry-based analytical datasets, and in particular with the OECD bilateral trade in goods by industry dataset (which is derived from merchandise trade statistics via standard Harmonized System to ISIC conversion keys). In order to maximise cross-country comparability, the database is relatively aggregated. To improve the quality of trade in value added results, however, it will be necessary to differentiate types of companies (particularly exporting and non-exporting companies) in a given sector. One area of future work will use micro-data to explore ways of improving the quality of results (see Annex 2.A2).

Bilateral trade matrices

National statistics offices are generally able to provide most of the blocks required to develop a global I-O table. However, while some countries are able to estimate the overall imports of a given product used by a particular industry, many are not. No country is able to show systematically the source of those imports (by originating country and industry) in the using industry (or final demand category).

The estimation of trade flows between industries and consumers across countries is therefore central to the construction of a global input-output table. However, national estimates of trade (exports and imports) are not coherent across countries (even after adjusting for price differences, c.i.f., f.o.b). The trade flows in intermediate goods and services used in the process of constructing a global I-O table confront this problem directly and are a means of tying together the individual national I-O tables. The work involved in developing a global I-O table therefore helps to reveal the sources of global imbalances. The results and their policy implications reveal 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.

In constructing the import flows (and export flows) of its global I-O table, the OECD necessarily relies on a number of assumptions. The main assumption used in creating the import matrices is "proportionality", i.e. that the (country) origin share of a given import consumed by a given industry in a given country is the same for all industries in that country. For countries that are unable to provide any "import-flow" matrices (i.e. the intermediate consumption of imports by product or industry by industries, the OECD assumes that the share of intermediate imports in total consumption of intermediates for a given imported product is the same for all using industries (and is equivalent to the overall share of intermediate imports in total intermediates supplied for that product).

In all cases the OECD has been able to improve the quality of the assumptions used by creating a new database of bilateral trade (for goods) that breaks down imports (and exports) according to the nature of the traded product (intermediate, household, investment, other). The Bilateral Trade Database by Industry and End-Use Category[6] (BTDIxE) is derived from United Nations Statistics Division (UNSD) COMTRADE Database, which compiles values and quantities of imports and exports 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 the Harmonized System, HS). Trade flows are classed according to the product classification used by the declaring country at the time of data collection. In general, source data are held according to the Standard International Trade Classification (SITC) Rev.2 for 1978-87, the Harmonized System (1988) for 1988-95, HS Rev.1 (1996) for 1996-2001, HS Rev.2 (2002) for 2002-06 and HS Rev.3 (2007) from 2007.

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 thus to the System of National Accounts (SNA) basic classes of goods (Table 2.5).

Table 2.5. Current Broad Economic Category (BEC) and System of National Accounts (SNA) classes of goods

		End-use			
		Intermediate	Final demand goods		Other
			Household consumption	Industrial capital goods	
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)		
		Fuel and lubricants e.g. gasoline (32)			
		Food and beverages (121) Industrial supplies (22) Parts and components of transport equipment (53) Parts and components of capital goods (42)			
	Processed finished	Packed medicaments (part of 63)			
			Non-industrial transport equipment (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 equipment (521)	
	Other				Goods n.e.c. (7)

Note: Numbers are BEC codes.

Source: United Nations Statistics, http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=10&Lg=1 (accessed May 2013).

In spite of the known problems relating to the asymmetries that exist in bilateral trade statistics, these bilateral statistics are used to populate the international flows of goods used in the OECD's global I-O table, before balancing (see below).

A similar approach is used for bilateral trade in services statistics. Estimates based on official bilateral statistics are the basis of the original estimates of exports and imports by country. However, the quality of bilateral trade in services statistics is notoriously poor. Therefore, the original partner share coefficients used to populate I-O cells for international trade in services are based on gravity model techniques (Miroudot et al., 2009) and are subsequently balanced within the overall system.

Bilateral trade flows (imports and exports) by partner country are consistent with the corresponding flows shown in their supply and use table (the basis for the creation of national I-O tables) and their national accounts in very few countries. This reflects the fact that, for goods at least, bilateral trade flows follow merchandise trade accounting standards.

Because the value-added flows are consistent with official GDP statistics, they are also consistent with the underlying gross export and import flows recorded in the national accounts. These trade figures will differ (significantly for some countries) from trade statistics based on merchandise accounting standards, and will often differ even more when bilateral trade balances are constructed. Issues at stake in reconciling the differences are:

Producing bilateral trade flows that are consistent with underlying supply-use tables should be a high priority of national statistics offices.

- *Confidential trade.* In some countries disclosure rules suppress 6-digit HS components in COMTRADE and even higher 2-digit HS chapter levels. This should be avoided where possible by adopting other means of preserving confidentiality, such as suppressing another 6-digit category.
- *Re-exports.* Adjustments are required for re-exports, which are significant at major continental trading hubs. Sufficient data are available to adjust for reported trade between China and the rest of the world via Hong Kong but not currently for other major hubs.
- *Identifying used/second-hand capital goods.* HS codes and therefore reported trade in COMTRADE do not differentiate between new and used 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 in order to record these flows in a way that aligns with the 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.

For services, countries are encouraged to provide more detail on partner countries and on the type of products (following EBOPS 2012).

Greater efforts are needed to reconcile asymmetries in international trade flows.

Balancing

Notwithstanding the resolution and implementation of the issues, the OECD's global I-O 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 (Ahmad et al., 2013).

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

More work ahead

The OECD-WTO TiVA Database allows for a better understanding of trade in a world increasingly characterised by global value chains. By necessity it requires a number of assumptions that largely reflect the fact that national statistics continue to be produced through a national prism. But this is gradually changing, and the larger statistics community has, in recent years, begun to produce new indicators and launch new initiatives to respond to the challenges raised by global value chains. The OECD-WTO initiative is one element of that overall effort, but it also acts as a stimulus to accelerate these initiatives and as a spotlight to highlight areas in which more can be done.

One of these areas is the need to attach more importance to resolving longstanding statistical issues, such as inconsistent mirror trade statistics. Another is the need to think about national statistics compilation in a way that builds in GVCs from the bottom up rather than as an afterthought or spillover. The OECD is working closely with countries and other international partners to achieve this via a number of initiatives (e.g. capturing and reflecting heterogeneity in supply-use tables, linkages of trade and business statistics at the firm level, better integration of foreign affiliates trade statistics (FATS) data with other core economic statistics). The results will eventually be incorporated into, and improve the quality of, the TiVA Database. In addition the OECD is working closely with its partners to motivate broader improvements in the core official statistics produced in emerging and developing economies, with a view to expanding the country coverage of the OECD-WTO TiVA database beyond its current coverage of 95% of global GDP.

Finally, there are plans to extend the indicators to other aspects of GVCs, in particular what they mean for jobs, and to capture (and re-allocate) income flows generated by foreign affiliates (trade in income). These future plans and initiatives are described in more detail in Annex 2.A2.

Notes

1. Fabless producers keep the design and sale of hardware devices and semiconductor chips while outsourcing the fabrication or "fab" of the devices to a specialized manufacturer.

2. An OECD 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.

3. Some research-oriented initiatives have used the GTAP Database for international input-output data. This is not however based on official sources of statistics.

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

5. Note by Turkey:

   The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus issue".

   Note by all the European Union Member States of the OECD and the European Union:

   The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

6. For further detail, see www.oecd.org/sti/btd.

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Annex 2.A1
Indicator descriptions and definitions

Gross trade indicators

Variable name	Variable description	Comments
EXGR	Gross exports by industry, USD million	All variables are consistent with official National Accounts estimates of total gross exports and total gross imports and GDP estimates with adjustments for re-exports included. Estimates by industry are based on the balanced pattern of trade derived within the global input-output database (see below).
IMGR	Gross imports by industry, USD million	
EXGR_GDP	EXGR as a % of GDP	
IMGR_GDP	IMGR as a % of GDP	
TSGR	Bilateral trade balances by partner country, USD million	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, e.g. through 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 % 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 million	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 a % of EXGR (by industry)	This reflects the domestic value added embodied in exports as a percentage 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 million	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 million	This reflects the indirect contribution of domestic supplier industries made through domestic (upstream) transactions.
EXGR_RIM	Re-imported domestic value added (by industry), USD million	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 million)	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 affect 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
IMGRFVA	Total foreign value added embodied in gross imports (by industry), USD million	Foreign content of gross imports.

Intermediate imports

Variable name	Variable description	Comments
REI	Intermediate imports embodied in exports as a % of total inter-mediate imports (by industry).	This reflects the share of intermediate imports used (indirectly and directly) in producing goods and services for export, as a percentage 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 competitiveness.

Value added embodied in final domestic demand

Variable name	Variable description	Comments
FDDVA	Domestic value added embodied in foreign final demand, by importing country and exporting (origin) industry, USD million	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). It reflects how industries (upstream in a value chain) are connected to consumers in other countries, even if no direct trade relationship exists. The indicator illustrates therefore the full upstream impact of final demand in foreign markets on domestic output. It can most readily be interpreted as "exports of value added".
FDDVASH	FDDVA by importing country and exporting industry as a % of total FDDVA, %	
FDDVA_GDP	FDDVA as a % of GDP, by importing country and exporting industry	
FDFVA	Foreign value added embodied in final domestic demand, by origin country and origin industry, USD million	Foreign value added embodied in final domestic demand shows where foreign value added originates for a final good or service (purchased by households, government, non-profit institutions serving households or as investment). It is the "import" corollary of FDDVA and shows how industries abroad (upstream in a value chain) are connected to consumers at home, even if 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 % of total FDDVA	
FDFVA_GDP	FDDVA as a % of GDP, by origin country and origin industry	
TSVAFD	Bilateral trade balances in value added by partner country (FDDVA minus FDFVA), USD million	The bilateral trade position in value-added terms.
TSVAFD_GDP	Bilateral trade balances in value added by partner country (FDDVA minus FDFVA), % GDP	
TSVAFD_TSGR	Difference in trade surpluses (value added in final demand minus gross trade) USD million	This reflects the change in bilateral trade positions.
FDDVA_EX	Domestic value added embodied in foreign final demand to gross export ratio	Also known as the VAX ratio.

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 percentage 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 million	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 million	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 million	This reflects the domestic services value added 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 million	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.	

Revealed comparative advantage

Variable name	Variable description	Comments
RCA_EXGR	Revealed comparative advantage based on gross exports, manufacturing sector	
RCA_EXGRDVA	Revealed comparative advantage based on domestic value added embodied in gross exports, manufacturing goods	

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

A: Gross trade indicators

Gross exports:

Country c's gross exports for a given industry i can be directly calculated from OECD's ICIO system 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.

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

Gross imports:

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

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

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

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

Gross trade surplus:

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

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

$$\text{TSGR\_GDP}_{c,i} = \frac{\sum_p \text{TSGR}_{c,p,i}}{\text{GDP}_c}$$

B: Gross trade decomposition (value added embodied in gross trade flows)

Gross exports by industry can be broken down into domestic and foreign value added content. 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

$$\text{EXGR\_DDC}_c = V_c \text{EXGR}_c$$

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

$$\text{EXGR\_IDC}_c = V_c (I - A_c)^{-1} \text{EXGR}_c \text{ - EXGR\_DDC}_c$$

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

$B = (1 - A)^{-1}$, is the global Leontief inverse matrix with NK x NK dimensions, and A is a global IO coefficient matrix. $B_{c,c}$ 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 demand. $B_{p,c}$ 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 demand.

Re-imported domestic value added content of gross exports

$$\text{EXGR\_RIM}_c = V_c B_{c,c} \text{EXGR}_c - \text{EXGR\_DDC}_c - \text{EXGR\_IDC}_c$$

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

Foreign value added content of gross exports

$$\mathrm{EXGR\_FVA_{c,p}} = u\mathrm{V_p B_{p,c}}\mathrm{diag}(\mathrm{EXGR_{c,p}})$$

$\mathrm{EXGR\_FVA_{c,p}}$ is a 1 x K row vector, representing partner country p's value added in country c's export. *u* is a 1 x K row vector of unity.

$$\mathrm{V_c} = \begin{bmatrix} \mathrm{v_{c1}} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \mathrm{v_{cK}} \end{bmatrix}$$

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 export from country c to country p for any given industry i, where c ≠ p. $\mathrm{EXGR_c}$ is total exports of country c.

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

$$\mathrm{EXGR\_FVASH_{c,i}} = \frac{\sum_p \mathrm{EXGR\_FVA_{c,p,i}}}{\mathrm{EXGR_{c,i}}} \times 100$$

$\mathrm{EXGR\_DDC_{c,i}}$ 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 share of gross exports are summed for all partners.

Domestic value added embodied in gross exports:

$$\mathrm{EXGRDVA_c} = \sum_p \mathrm{EXGRDVA_{c,p}} = \sum_p \mathrm{V_c B_{c,c} EXGR_{c,p}}$$

Foreign value added embodied in gross imports:

$$\mathrm{IMGRFVA_c} = \sum_{\mathrm{p}} \mathrm{IMGRFVA_{c,p}} = \sum_{\mathrm{c}} \mathrm{V_p B_{p,p} EXGR_{p,c}}$$

$\mathrm{EXGRDVA_{c,p}}$ and $\mathrm{IMGRDVA_{c,p}}$ are both K x 1 vectors, representing country c's domestic value added embodied in gross export to country p and country p's value added embodied in country c's import respectively, for any given industry i. Both variables are aggregated for all partners.

Value Added Export Ratio - total domestic value added share of gross exports, %

$$\mathrm{EXGRDVA\_EX_{c,i}} = \frac{\mathrm{EXGRDVA_{c,i}}}{\mathrm{EXGR_{c,i}}} \times 100$$

C: Re-exported intermediates

Re-exported intermediates as a % of total intermediate imports

$$\mathrm{REI_{c,i}} = \left(\sum_{\mathrm{p}} \mathrm{A_{p,c} B_{c,c} EXGRF_c} \right)_{\mathrm{i}} / \sum_{\mathrm{p}} \mathrm{IMGRI_{c,p,i}}$$

$\mathrm{A_{p,c}}$ is a K x K off-diagonal block matrix of A giving c's requirements in imported intermediate products sourced from country p per unit of output.

$\mathrm{EXGRF_c}$ is K x 1 vector, representing exports in final demand from c to p for each industry i.

$\mathrm{A_{p,c} B_{c,c} EXGRF_c}$, 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. $\left(\sum_{\mathrm{p}} \mathrm{A_{p,c} B_{c,c} EXGRF_c}\right)_{\mathrm{i}}$ refers to the i-th element of the vector, and gives total intermediate goods and services absorbed by country c that originated from all foreign countries in industry i.

$\sum_{\mathrm{p}} \mathrm{IMGRI_{c,p,i}}$ is total intermediate imports of country c from each industry i.

D: Value added embodied in final domestic demand

Domestic value added embodied in foreign final demand

$$\mathrm{FDDVA_{c,p}} = \mathrm{V_c} \sum_{\mathrm{s}} \mathrm{B_{c,s} EXGRF_{s,p}}$$

$\mathrm{FDDVA_{c,p}}$ and $\mathrm{EXGRF_{s,p}}$ are K x 1 vectors. $\mathrm{EXGRF_{s,p}}$ represents final demand produced in country s that is finally consumed in partner country p . $\mathrm{B_{c,s}}$ is the off diagonal block matrix of global Leontief inverse matrix 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

$$\mathrm{FDDVASH_{c,p,i}} = \frac{\mathrm{FDDVA_{c,p,i}}}{\sum_{\mathrm{p}} \mathrm{FDDVA_{c,p,i}}} \times 100$$

$\mathrm{FDDVA_{c,p,i}}$ 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

$$\mathrm{FDFVA_{c,p}} = \mathrm{V_p} \sum_{\mathrm{s}} \mathrm{B_{p,s}EXGRF_{s,c}}$$

$\mathrm{FDFVA_{c,p}}$ 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 home country c .

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

$$\mathrm{FDFVASH_{c,p,i}} = \frac{\mathrm{FDFVA_{c,p,i}}}{\sum_{\mathrm{p}} \mathrm{FDFVA_{c,p,i}}} \times 100$$

$\mathrm{FDFVA_{c,p,i}}$ 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)

$$\mathrm{TSVAFD\_TSGR_{c,p}} = \sum_{i} \mathrm{TSVAFD_{c,p,i}} - (\sum_{\mathrm{i}} \mathrm{EXGR_{c,p,i}} - \sum_{\mathrm{i}} \mathrm{IMGR_{c,p,i}})$$

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

$$\mathrm{FDDVA\_EX_{c,p}} = \frac{\sum_{\mathrm{i}} \mathrm{FDDVA_{c,p,i}}}{\sum_{\mathrm{i}} \mathrm{EXGR_{c,p,i}}} \times 100$$

E: Services

Direct domestic service industry value added content of gross exports

$$\mathrm{EXGR\_DDC\_SV_{c,i}} = \mathrm{V_{c,j}EXGR_{c,i}}$$

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

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

Re-imported domestic services value added content of gross exports

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

Foreign services value added content of gross exports

$$\mathrm{EXGR\_FVA\_SV_{c,i}} = \sum\nolimits_{p} \sum\nolimits_{j \in S} \mathrm{V_{p,j}}\left(\mathrm{B_{p,c}}\right)_{ji}\mathrm{EXGR_{c,p,i}}$$

$\mathrm{EXGR\_DDC\_SV_{c,i}}$ 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.

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

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

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

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

$$\mathrm{SERV\_VAGR_{c,p,i}} = \sum\nolimits_{j \in S} \mathrm{V_{p,j}}\left(\mathrm{B_{p,c}}\right)_{ji}\mathrm{EXGR_{c,p,i}} \Big/ \sum\nolimits_{p} \mathrm{EXGR_{c,p,i}}$$

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

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

$$\mathrm{SERV\_VAFD_{c,p,i}} = \sum\nolimits_{j \in S} \mathrm{V_{p,j}}\left(\mathrm{B_{p,c}}\right)_{ji}\mathrm{EXGRF_{c,p,i}} \Big/ \sum\nolimits_{p} \mathrm{EXGRF_{c,p,i}}$$

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

F: Revealed comparative advantages

Revealed comparative advantage based on gross exports, manufactured 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, manufactured 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 $\mathrm{EXGRDVA}_{c,p}$.

Annex 2.A2
Future improvements

Improving quality

Indicators created via input-output (I-O) 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 as assuming that there exists only one production technique for all of the firms (and all of the products) in the industry grouping. Obviously, this is not true and different firms, even those producing the same products, will have different production techniques, and therefore different technical I-O coefficients. Also, different firms produce different products and these products will be destined for different types of consumers and markets.

Of chief concern in this respect is the evidence that points to very different coefficients for exports than for goods and services produced for domestic markets, particularly when the exports (typically intermediates) are produced by foreign-owned affiliates in a global value chain. Because exporting firms are generally more integrated into value-added chains they typically have higher foreign content ratios, particularly when they are foreign owned. Generally, therefore, an inability to account for this heterogeneity when 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.

It is important to note, however, that more detail does not necessarily translate into more disaggregated industries. What is important for indicators on global value chains is more detail on firms that trade internationally. In this sense, given a choice between doubling the number of industries available in current national I-O or supply use (SU) tables or splitting existing industries into groups of exporting firms and non-exporting firms, the latter may arguably be preferable. The OECD is working with its constituencies of national statistics institutes to introduce changes such as these in official supply-use and/or input-output tables. In a project co-ordinated 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 (Cuihong, 2013).

Trade in jobs

Looking at trade in value-added terms provides valuable insight into broader notions of competitiveness (in addition to providing insight into trade policies) by illustrating linkages among countries and by revealing the activities (or tasks) that generate the most value. Additional indicators and insights can be gained by considering extensions to the accounting framework.

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). It is hoped that highlighting the insights that can be gained by looking at trade in jobs will reinforce and support national initiatives aimed at improving coherence. Going a step further, particularly because international fragmentation has meant that industries across countries are less comparable than they used to be (as they increasingly specialise in the stages of the underlying activity in which they have a comparative advantage) it is increasingly 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] Rev.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.

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 (IP) products.

Consider for example an affiliate enterprise, recognised in the national accounts of its resident economy as the economic owner of the IP that it uses to produce the 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 IP) that benefits from the use of the IP (this of course raises questions about how economic ownership of IP should be considered as regards multinationals, an issue that is currently being tackled by the international statistics community).

But the difficulties raised by the current recording of IP in countries' balance of payments and national accounts go 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 transfer the owner makes to its affiliates, often for tax minimisation purposes. The owner may also transfer the asset to an affiliate, such as a special purpose enterprise (SPE), and the parent and other affiliates may make explicit payments to the SPE, again for tax minimisation purposes.

What is clear, therefore, is that flows related to IP require an extension of accounting systems beyond value-added flows in order to understand fully who benefits from trade and indeed from 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).

The flows merely illustrate a wider issue, despite the obvious implications for calculating multifactor productivity. First, they illustrate the distortions that may arise when the scope for transfer pricing manipulations is factored in. Second, they concern more than 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. Even though these assets are not recognised in the SNA, the profits recorded by the affiliate compensate for their use and eventually flow back to the parent as reinvested earnings flows in the accounts. However, these flows are typically not available on a bilateral partner country basis, let alone a partner country-industry basis, which is needed for an analysis of trade in income analogous to that for trade in value added.

Recording these flows is therefore crucial. Part of the solution lies in producing supply-use tables (or indicators) that capture foreign ownership. 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 exist. Foreign affiliate trade statistics can be combined for example with information in supply-use tables that gives breakdowns based on ownership. There is also scope to link this further to balance of payment 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: between 1995 and 2007, Japanese foreign affiliates increased their employment in China from just over 100 000 employees to over 1 000 000 and in Thailand from 300 000 to over 400 000, with similar patterns in countries such as the Philippines, Malaysia and Indonesia. From 1995 to 2009, Japan's primary income trade surplus increased by around USD 100 billion, more than offsetting the USD 50 billion reduction in its gross trade surplus over the same period.

Trade in CO_2 (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 I-O tables (Ahmad and Wyckoff, 2003).

Incorporating capital flows

Other areas in which extensions to the accounting framework would be desirable include the contribution made by capital more generally. Because of the way capital 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 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. 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.

Distribution sectors and trade

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