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## Trade in value added: Concepts, estimation and analysis

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# Trade in Value Added: Concepts, Estimation and Analysis



**Marko Javorsek**  
**Ignacio Camacho**

ASIA-PACIFIC RESEARCH AND TRAINING NETWORK ON TRADE

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## Trade in Value Added: Concepts, Estimation and Analysis<sup>#</sup>

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## **Abstract**

This working paper introduces the concept of Trade in Value Added (TiVA) and presents an initial analysis of TiVA for selected regional ESCAP economies. The paper introduces Global Value Chains (GVCs) and issues for the measurement of trade statistics due to proliferation of GVCs. It further presents the TiVA estimation methodology, as defined in the literature, and provides an overview of the data requirements for estimation. The paper reviews current initiatives on regional / international input-output tables (IOTs) and TiVA analysis, and availability of data in the Asia-Pacific region. The paper concludes with a TiVA analysis of selected regional ESCAP economies that are available in the current data sources. The paper has been prepared under the Regional Programme on Economic Statistics (PRES) and we hope it will support the efforts of statistical offices in the region to improve related statistics.

**Keywords:** international trade statistics, trade in value added, global value chains, Asia and the Pacific, input-output, supply-use,

**JEL classification:** C67, D57, F13, F14, F15, F23, O19, O24

## Contents

1. Introduction.....	1
2. Understanding international trade statistics.....	2
2.1. Global Value Chains (GVCs).....	2
2.2. Trade statistics.....	4
2.3. Measurement of trade.....	5
2.4. Trade in Value Added (TiVA).....	6
2.5. The TiVA framework of indicators.....	8
2.5.1. TiVA and trade in services.....	9
2.5.2. GVC participation.....	10
3. Estimating Trade in Value Added (TiVA).....	11
3.1. International input-output tables .....	11
3.1.1. Basic assumptions.....	14
3.2. Estimating TiVA.....	16
4. Current initiatives in TiVA analysis.....	21
4.1. OECD and WTO.....	23
4.2. UNCTAD and Eora MRIO .....	23
4.3. Other initiatives.....	25
5. TiVA analysis for selected ESCAP economies.....	26
5.1. Description of the data sources .....	26
5.2. Regional TiVA.....	27
5.3. TiVA by industry.....	30
5.4. TiVA analysis of services contribution to exports .....	33
5.5. Participation in GVCs.....	34
Conclusion.....	37
References.....	39

## Figures

Figure 1: An illustration of a GVC .....	2
Figure 2: Trade in value added, an illustration.....	6
Figure 3: Decomposition of gross exports: concepts .....	9
Figure 4: Simplified supply and use table .....	12
Figure 5: Simplified input-output table .....	13

Figure 6: Simplified international IOT with two countries and one industry .....	14
Figure 7: Disaggregation of gross exports for 17 ESCAP economies in Asia-Pacific, 2009 in trillion US\$ .....	27
Figure 8: Shares of domestic value added in gross exports, 2009.....	28
Figure 9: Values of the domestic and foreign value added embodied in gross exports, 2009 in billion US\$.....	29
Figure 10: Domestic value added (DVA) and gross exports (GE) as a percentage of GDP, 2009.....	30
Figure 11: Total domestic value added of services and indirect domestic services as a share of gross exports, 2009.....	34
Figure 12: Forward and backward GVC participation indices, 2009 .....	36

## Tables

Table 1: 2009 US trade balance in iPhones (million dollars).....	7
Table 2: List of international IOT databases .....	22
Table 3: List of TiVA databases .....	22
Table 4: Domestic value added in gross exports ratios by industry, 2009.....	30
Table 5: Each industry as a percentage of gross exports (GE) and their domestic value added (DVA) to gross exports (GE) ratios for Australia and China, 2009 .....	32

## **1. Introduction**

Current trade statistics do not fully reflect how much the economies have become interconnected and interdependent. Trade statistics are also becoming increasingly less reliable in measuring the value contributed by each economy. As a result new measures and methods have been proposed to measure the actual (domestic) value added contribution of each economy. One of the recent developments to improve trade statistics is the introduction of the concept of Trade in Valued Added (TiVA), which could properly measure exports of an economy.

One of the main motivations behind the recent revisions of the major macroeconomic statistical frameworks was to be able to provide a more realistic picture of the integrated economic activity, where international production networks play a key role. Global Value Chains (GVCs) have made the analysis of international trade more complex and the statistics on gross exports and imports inadequate to measure the real flows of value added between economies. The gross trade statistics are also inconsistent with the principles of the System of National Accounts (SNA) based on the value added principle, as opposed to current trade statistics measured in gross terms, including both the final products and intermediate inputs, which cross international borders more than once.

This working paper aims to explain the concept of TiVA, how is it measured, and how it can help us understand trade flows in a more comprehensive way. The paper begins with explaining GVCs, main concepts of trade statistics, and explaining how TiVA is estimated. In continuation, the paper reviews the current initiatives in constructing regional/international IOTs and estimates of TiVA involving economies in Asia-Pacific, and concludes with an empirical analysis of TiVA in selected ESCAP economies.



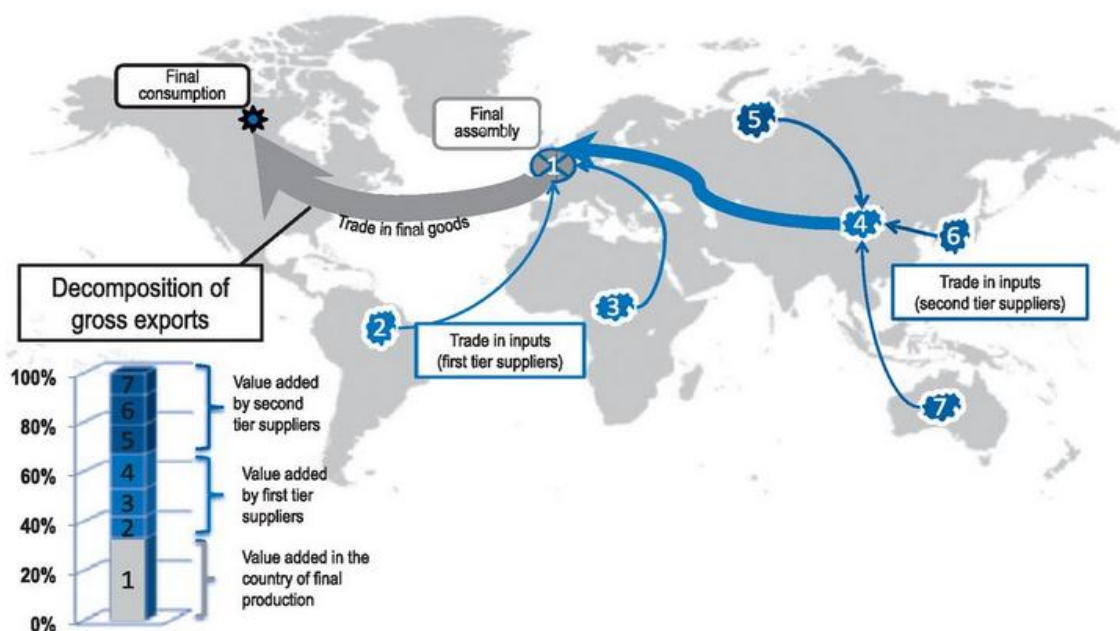
## 2. Understanding international trade statistics

This section introduces the basic concepts of GVCs and trade statistics, from the traditional way of measurement to explaining the main concepts of TiVA. The aim of this section is to motivate the interest in this area and provide the necessary background information about the basic concepts.

### 2.1. Global Value Chains (GVCs)

Global Value Chains (GVCs) is a phenomenon where the making of a product is spread across countries, regions and continents benefiting from comparative local cost advantages to become globally competitive. GVCs are value chains, which are activities that companies engage in to bring a product from development all the way to the final consumer, and that are global in a way that are spread over several countries (Gereffi and Fernandez-Stark, 2011). GVCs depend on fragmentation of production and trade of intermediate products in order to exploit cost advantage of each location/stage in the chain, up to the assembly stage. GVCs are typically used by transnational companies and have become increasingly important. Figure 1 illustrates flows in a GVC.<sup>1</sup>

**Figure 1: An illustration of a GVC**



Source: OECD, 2013.

<sup>1</sup> For an overview on GVCs see Gereffi and Fernandez-Stark, 2011; or De Backer and Miroudot, 2013; of OECD-WTO-WB, 2014.

The development of GVCs has been mainly driven by multinational companies in their pursuit of competitive advantage and profits. By carrying out specific parts of the production process in certain countries, costs are minimized through economies of scale as well as specialization in addition to local cost advantages. Furthermore, the international movements of intermediate products are facilitated by trade liberalization and decline of transport and ICT costs. The concept “Made in...” becomes blurred as many products are, actually, “Made in the World”. In fact, according to UNCTAD (2013b), 80% of gross exports are currently linked to international production networks of transnational companies.

GVCs are an important phenomenon in Asia-Pacific, initially spearheaded by Japanese investors who took their production bases to several countries in East Asia and later also to South-East Asia in order to access location advantages and develop export platforms to avoid adverse exchange rate developments.<sup>2</sup> The assembly of final products was carried out in a third country upon which the products were exported back to Japan or onto the global markets. Due to increasing levels of foreign direct investment, GVCs in Asia are now connected to most countries and sub-regions; in fact, East and South-East Asia are leading the developing world in terms of integration into GVCs (UNCTAD, 2013b). In particular, China has become world’s factory with transnational companies relocating their production platform in the country.<sup>3</sup>

Due to their increasing importance it is fundamental to include GVCs in the recording and analysis of the trade flows. This will, however, demand significant changes to the analysis of trade statistics and statistical standards. In this regard, efforts have been made to revise the major macroeconomic statistical frameworks (e.g. the 2008 System of National Accounts – SNA– and the 2009 Sixth Edition of the Balance of Payments and International Investment Position Manual –BPM6) in order to give a more realistic picture of national and international economic activities.

The SNA has been revised replacing the “cross border recording of goods and services” with “transfer of economic ownership” in order to delineate trade activity, and the BPM6 has been harmonized with the 2008 SNA. To address challenges, among others, related to

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<sup>2</sup> The Japanese production moved off-shore (particularly to South-East Asia) in a big way following the Plaza Accord in 1985 when Japan was forced to revalue its currency against the US dollar (ESCAP, 2014b).

<sup>3</sup> Facilitated by low labour cost, favourable exchange rates and policies such as the export tax rebate policy, initiated in 1985 as a way to boost the competitiveness of its exports by abolishing double taxation on exported goods. Exported goods are subject to zero per cent value added tax (VAT), meaning they enjoy a VAT exemption or rebate policy. China also has developed manufacturing ecosystems where a network of suppliers that provide parts to the final assembly factory and are essential for efficient and low cost production to attract foreign investment (ESCAP, 2014b; Economist, 2012; and ADB, 2013).

implementing these revisions, the following groups have been established to provide input: Inter-secretariat Working Group on National Accounts (ISWGNA), and Eurostat Task Force on Goods sent abroad for Processing. As a result the following manuals have been prepared: The Impact of Globalization on National Accounts (UNECE, 2011), Guide to Measuring Global Production (UNECE, 2015), and Guidelines on Integrated Economic Statistics (UNSD, 2013).

Various international organizations, universities, independent researchers, and international think tanks have suggested that the measurement of international trade using a value added approach could provide better statistics and allow more meaningful analysis of the impact of international trade on growth and economic development. It would also address the problem of double counting and improve evidence-based policy making worldwide.

## **2.2. Trade statistics**

On a global level, trade<sup>4</sup> statistics are gathered by different international organizations, among others, the International Monetary Fund (IMF), the World Trade Organization (WTO) and the United Nations Statistics Division (UNSD). Trade statistics are collected from various national agencies, such as the national statistical office (NSO), the national customs agency, or central bank, as well as supranational institutions, such as the European Commission or Organization of Economic Co-operation and Development (OECD).

Trade is composed of trade in merchandise and trade in services. In this paper we are mainly concerned with trade in merchandise. One of the primary sources of trade in merchandise statistics is the Commodity Trade Statistics Database (UN Comtrade).<sup>5</sup> Comtrade collects trade statistics from national institutions on trade in merchandise at disaggregated levels, including information about the type of goods, the country of origin for imports and the country of last known destination for exports. Imports are recorded at transaction value, including cost, insurance and freight (CIF), whereas exports are recorded at free on board (FOB) prices (i.e., cost, insurance and freight are not considered in the price). Data at the product level is classified using the Harmonized Commodity Description and Coding System (Harmonized System or HS), as well as the Standard International Trade Classification (SITC), which assigns commodities according to their stage of production.

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<sup>4</sup> In this paper “trade” implies international trade, if the trade would refer to domestic trade it would be specified.

<sup>5</sup> For more information see: <http://comtrade.un.org/db/mr/rfGlossaryList.aspx>.

In the case of Asia-Pacific, ESCAP statistical database compiles statistics on trade for countries in the ESCAP region from the United Nations Conference on Trade and Development (UNCTAD), the WTO, and UN Comtrade. For calculation of regional and subregional aggregates ESCAP imputes missing values, but the imputed values are not presented in the database. Some inconsistencies between trade data sources occur mainly due to different national sources used, translation of currencies, and differences in standards.

### **2.3. Measurement of trade**

Trade statistics are produced based on recording of products' crossing the national customs borders. This process disregards the fact that intermediate inputs used to produce the product exported from one country may be imported from several other countries. For example, if China exports a microwave oven to the United States the total export value of the microwave oven is considered as Chinese export and recorded as such in the trade account by national authorities; and from the United States perspective, the microwave oven is recorded as an import from China (and will probably require a tag "Made in China"). However, some of inputs into the production of the microwave oven might have been produced in and imported from different countries, for example Thailand, Malaysia or even the United States. The value of these intermediates has been recorded as Chinese imports from Malaysia, Thailand, or the United States, but not linked with the exportable final product.

At present, trade statistics does not differentiate whether the intermediate products in the production of the microwave oven were produced in China or not; thus possibly inflating the role of exports for China. Furthermore, this recording of trade creates double, triple or multiple counting in international trade. The total value of the microwave oven was counted as a final export of China, but so were the inputs and parts exported from the other countries, which quite likely also had imported inputs which in turn were recorded as exports by countries where those originated. Hence, the total exports are over-estimated at the global level, as well as in many countries making current measures of ratios of exports to GDP inadequate. At the extreme in economies where re-exports are significant, such as in Singapore and Hong Kong, China, this could mean exports exceeding the total value of GDP.

Due to the increasingly interlinked global production networks, double counting of international trade has been estimated at around \$5 trillion or 28% of the \$19 trillion of global gross exports in 2010 (UNCTAD, 2013a). The increasing importance of global value chains has significantly aggravated this problem. In a GVC multinational companies aim to fragment the production of

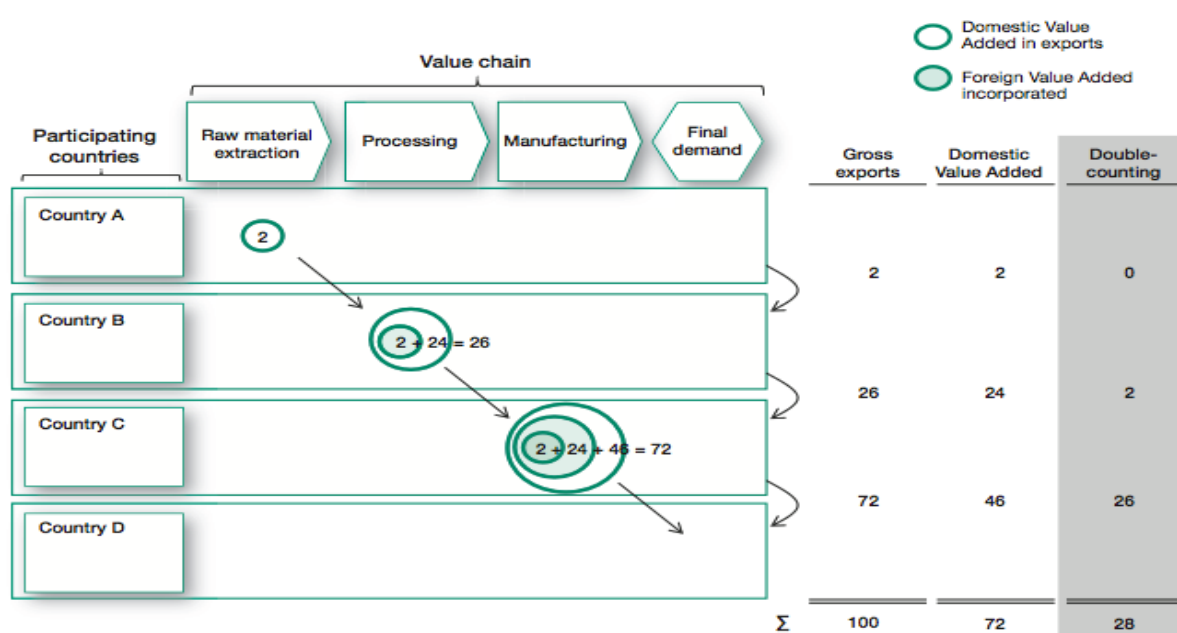
products in the most optimal location, which means that products are rarely produced completely in a single country.

## 2.4. Trade in Value Added (TiVA)

Trade in Value Added (TiVA) is a concept of measuring trade based on the value added at each stage of production. As a result, only the amount of value added by a particular country in the production of a particular exportable product will be recorded as exports of this country. This means that in the above example of the microwave oven exported from China to the United States, only the value added produced by Chinese manufacturers in the total value of the oven will be recorded as the Chinese export to the United States.

As such, TiVA addresses the double counting implicit in current gross trade data by measuring flows in terms of the value that is added by a country in the production of goods and services. This principle is illustrated in figure 2, where a product is produced in three different countries and sold for final consumption in the fourth country. In this example, we can see that traditional measurement of trade results in, for example, total \$100 of gross exports between the countries; however, measuring only domestic value added as the value of exports (TiVA principle) will result in \$72 of trade between these countries. In other words, in this example, the value of exports is overvalued by \$28 in the traditional trade measure compared to the value added measure.

**Figure 2: Trade in value added, an illustration**



Source: UNCTAD, 2013a.

By recording trade in value added, the overall trade balance of a country with the rest of the world will not change; however, bilateral trade balances may change significantly. For example, we can look at the United States trade deficit with China in the trade of iPhones. The decomposition of this trade by the value added produced by different countries involved in the production of the iPhones reveals a very different picture compared to the one given by traditional trade measures. Table 1 shows the trade in iPhones between China and the United States in both traditional trade measure and the value added produced by each country involved in the production chain. We can see that China adds only a small part (3.9%) to the overall value of the iPhones exported to the United States. This means that the trade deficit in net terms between China and United States is much smaller. The rest of the trade deficit is with Japan, Germany, the Republic of Korea and other countries where critical components are produced and R&D centres located.

**Table 1: 2009 US trade balance in iPhones (million dollars)**

	China	Japan	Korea, Rep. of	Germany	Rest of world	<b>World</b>
Traditional measure	-1,901.2	0	0	0	0	<b>-1,901.2</b>
Value added measure	-73.5	-684.8	-259.4	-340.7	-542.8	<b>-1,901.2</b>

Source: Maurer, 2011; Meng and Miroudot, 2011; and Xing and Detert, 2010.

In general, measuring trade in terms of value added can bring the following benefits and impact policies (UNECE, 2015):

- Understand how and where domestic value added is created by the exports of goods, which is crucial to comprehend how trade contributes to economic growth and competitiveness;
- Understand how upstream domestic industries contribute to exports, even if those same industries have little direct international exposure (e.g. services used in production of goods exported);
- Understand trade (im)balances in value added terms, as in the iPhone example above;
- Understand the links between trade and employment, i.e. where jobs are created and which domestic industries are involved;

- Provide policy makers a better understanding of potential impacts of macroeconomic shocks on trade (e.g. the 2008/09 financial crisis);
- Understand the environmental impact of trade, the potential impact of trade on climate change, and how trade affects greenhouse gas emissions.

## 2.5. The TiVA framework of indicators

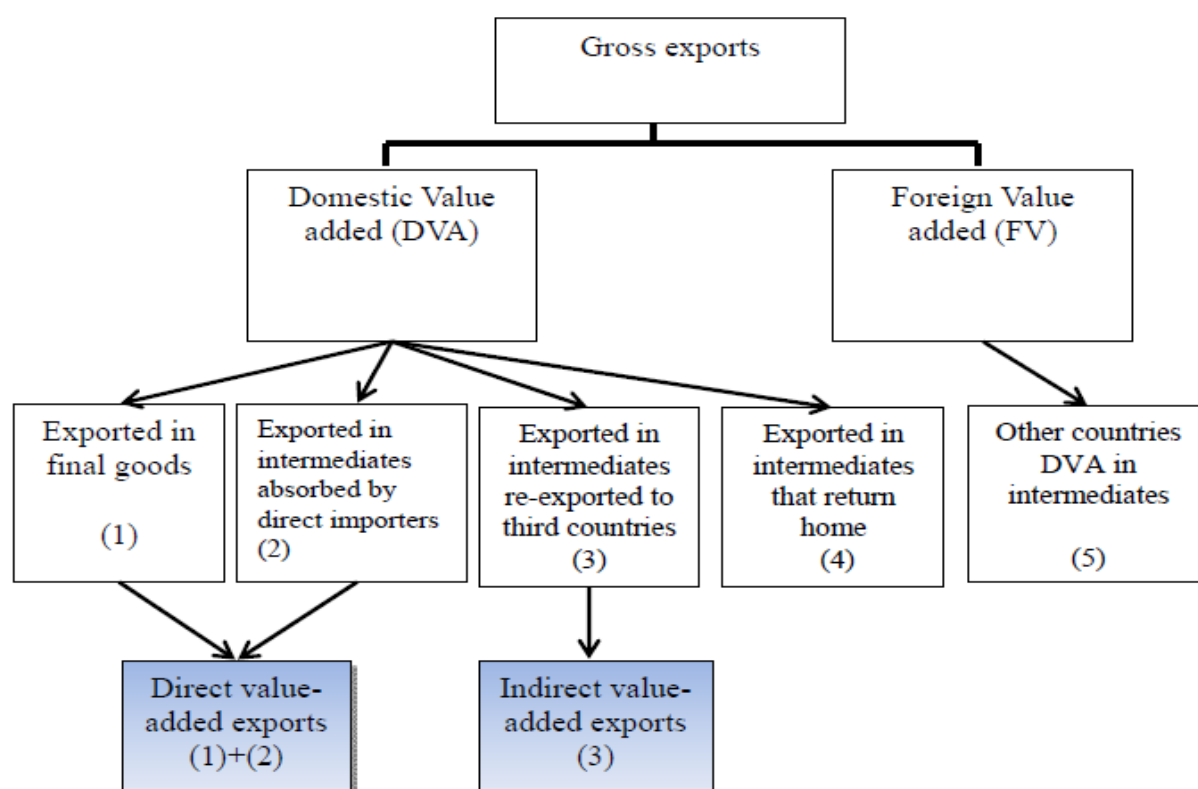
The concept of TiVA refers to a series of different indicators of domestic and foreign value added embodied in imports and exports. The following two are the most commonly used indicators and form the basis of gross export (GE) disaggregation in value added terms (OECD-WTO, 2013b):

- Domestic value added embodied in gross exports (DVA): refers to the value added generated by the domestic economy in the production (direct and indirect) of goods and services for export. It includes the value added embodied in all exported goods and services produced by national industries, including the domestic value added that was previously exported and the re-imported to be used in production of intermediates.
- Foreign value added embodied in gross exports (FVA): refers to the value added of foreign goods and services that are used as intermediates to produce goods and services for export. FVA is usually analysed by the country of origin.

Additionally, when speaking of the domestic value added embodied in gross exports (DVA), we also need to define the portion of this domestic value added used as inputs by industries in other countries, which produce goods or services for export to third countries, this is also referred to as the indirect value added exports (DVX).

For complete disaggregation of gross exports (GE), the DVA part can further be decomposed into: exported final goods; exported intermediates used for production of goods and services for domestic consumption (the former and the latter are together referred to as direct value added exports); exported intermediates used to produce goods and services intended for export to third countries, or the indirect value added exports (DVX); and exported intermediate goods that were used for production of good and services and then imported back to the initial country, or the re-imported domestic value added. The decomposition of gross exports and the basic concepts are also illustrated in figure 3.

**Figure 3: Decomposition of gross exports: concepts**



Source: Koopman et al, 2010.

### 2.5.1. TiVA and trade in services

The increased use of services in manufacturing has resulted in a phenomenon called ‘servicification,’ which recognizes the direct and indirect value created by services in the process of manufacturing, distribution, or marketing of goods (ESCAP, 2013). Traditionally we value goods disregarding how upstream domestic economic activities (industries), those in the initial stages of production, contribute to their creation.<sup>6</sup> Therefore, we underestimate the weight of services used in the design and commercialization of such goods.<sup>7</sup>

Analysis of TiVA is especially helpful as it allows us to understand the contribution of services in domestic production and their value added contribution to trade. TiVA framework identifies two indicators that allow for the analysis of the value added of the services industry (OECD-WTO, 2013b):

<sup>6</sup> A more thorough definition of upstream and downstream activities is provided below.

<sup>7</sup> For further discussion on servicification and industrial exports see ESCAP, 2014a; and Anukoonwattaka et al, 2015.



- Total domestic value added of the services embodied in gross exports (SDVA): reflects the (direct and indirect) value added contributions of domestic services supplied in producing a good or service for exports, including the domestic services value added that was previously exported in goods and services used to produce the intermediate products. By definition, it will be zero for all non-service industries.
- Foreign services value added share of gross exports (SFVA): refers to the foreign services value added of foreign intermediate goods and services used by the exporting economy, usually analysed by country of origin.

### 2.5.2. GVC participation

We can analyse the countries' and industries' participation in GVCs from two different perspectives:

- *Forward linkages or downstream participation*: is created between a supplying industry and a purchasing industry that uses the supplier's output as input. Internationally, it can be understood as the linkages between an exporting economy and an importing economy whose industries use the exports (supply) as inputs to generate output for exports. In other words, the industries of the exporting country provide inputs into exports of the industries in the importing country.
- *Backward linkages or upstream participation*: is created between a purchasing industry and a supplying industry. Internationally, it can be understood as the linkages between an importing country and an exporting country. In other words, the industries in the importing country import intermediate products to be used in its exports.

The above concepts will allow us to measure the GVC participation, which indicates a country's integration into the GVCs. It is calculated by adding the foreign value added in the country's exports (FVA) – backward linkage – and the domestic value added embedded in exports of other countries (DVX) – forward linkage. Consequently, the GVC participation index is the sum of the forward linkage (downstream participation, DVX) and the backward linkage (upstream participation, DVA) divided by total gross exports (GE), as proposed by Koopman et al (2010):

$$GVC_{\text{Participation}} = \frac{DVX + FVA}{GE} \quad (1)$$

Forward and backward linkages are useful in understanding the impact of trade on economic growth and development. In this regard, a country which exports high levels of final goods that use few domestic intermediates (i.e. a country with weak domestic backward linkages in its exporting sector) will generate little domestic value added and little economic growth when increasing its exports; as opposed to a country with high levels of integration between its domestic and export industries (i.e. strong domestic backward linkages). It is important to note that, in our example, weak domestic backward linkages may imply strong international backward linkages, i.e. high levels of imports of intermediate goods (UNCTAD, 2013a).

Normally, countries with weak domestic backward linkages in their exporting sectors also have weak international forward linkages (with the exception of countries whose main exports are natural resources). In this regard, an economy specializing in the assembly of final goods that imports high levels of intermediates will itself produce few intermediates destined to exports. Given that the final stages of production (i.e. assembly) usually carry the lowest levels of value added, achieving economic development would require that countries develop both strong domestic backward linkages and strong international forward linkages (UNCTAD, 2013a).

### **3. Estimating Trade in Value Added (TiVA)**

This section presents the process of estimating TiVA. The process consists of two stages; the first one is to construct an international/regional input-output table (IOT), which in itself requires several steps, significant amounts of data, and making some assumptions. This will, in turn, feed into the TiVA estimation in the second stage.

#### **3.1. International input-output tables**

In brief, the supply and use tables (SUTs) show the whole economy, providing data on the supply of goods and services produced domestically or imported, and the use of goods and services as intermediates in production or as final products (Eurostat, 2008). Hence, the SUTs give us the detailed view on the entire economy through the production processes, their interactions, how goods and services are used and how they generate income; in effect they link industries, products and sectors. On the other hand, the IOTs are a transformation of the SUTs and provide aggregated data on production and consumption by sectors/industries (UNSD, 2013).

Figure 4 is a simplified presentation of an SUT at a national level. The SUT is divided into a supply side and a use side. The supply side provides information on the origin of goods and services and consists of both domestic production and imports. The use side contains information about how each good or service is utilized, either by other producers (intermediate consumption), by final consumers (final consumption), as investment (capital formation), or by consumers from other countries (exports). Total supply must equal total use.

**Figure 4: Simplified supply and use table**

Goods and services	Supply		Total supply = total use	Use						
	Domestic Production	Imports		Intermediate Consumption	Final Consumption Expenditure			Capital Formation		Exports
					Government	Households	Nonprofit institutions Serving Households	Gross Fixed Capital Formation	Changes in Inventories	
Goods										
1										
2										
Services										
1										
2										
Total										

Source: ADB, 2012.

Figure 5 in turn presents a national IOT in a simple way by aggregating all industries into 8 sectors. In the rows we can see the distribution of each sector's output (the inter-industry transactions and sales to final consumers). In the columns we can see the inputs required in production by each sector, plus the value added generated domestically, which is reflected in the employees' compensation, capital income, and indirect business taxes. National IOTs allow us to understand the interaction between domestic industries.

**Figure 5: Simplified input-output table**

		Producers as Consumers								Final Demand			
		Agriculture	Mining	Const.	Manuf.	Trade	Transp.	Services	Other	Personal Consumption Expenditures	Gross Private Domestic Investment	Govt. Purchases of Goods and Services	Net Exports of Goods and Services
Producers	Agriculture												
	Mining												
	Const.												
	Manuf.												
	Trade												
	Transp.												
	Services												
	Other												
Value Added	Employees	Employee compensation								Gross Domestic Product			
	Business Owners and Capital	Profit-type income and capital consumption allowance											
	Government	Indirect business taxes											

Source: Miller and Blair, 2009.

For estimation of TiVA national SUT, or at least IOTs, are needed. Ideally, national level SUTs are available in the creation of international IOTs, due to their specificity as they provide information on both products and industries (OECD-WTO, 2012). Nonetheless, SUTs are not easy to compile and they are available for a limited number of countries. In most cases national IOTs are used, which can even be compiled using a range of technology assumptions.

National IOTs are generally used to produce regional or international IOTs required for the estimation of TiVA. Sometimes detailed national IOTs are not available for small economies. In such cases, experts estimate the tables using different technology assumptions at the industry and product levels (UNCTAD, 2013a). Such assumptions may be obtained from the provider of the national data.

Even if national IOTs or SUTs contain high levels of detail, they do not provide information on the sources of imports or export destinations for each industry. Therefore, in the process of creation of the international IOT apart from the national IOTs/SUTs one also needs a database on bilateral trade data for all countries involved. This information is needed to allocate imports and exports to each industry in every economy. Along the bilateral trade statistics, a number of important assumptions and adjustments are also needed (OECD-WTO, 2012). Figure 6 shows a simplified international IOT with only two-countries and one industry.

**Figure 6: Simplified international IOT with two countries and one industry**

		Intermediate use		Final demand		Gross output
		Country A	Country B	Country A	Country B	
		Industry	Industry	Industry	Industry	
Country A	Industry	Intermediate use of domestic output	Intermediate use of B of exports from A	Final use of domestic output	Final use by B of exports from A	Xa
Country B	Industry	Intermediate use of A of exports from B	Intermediate use of domestic output	Final use by A of exports from B	Final use of domestic output	Xb
Value added		Va	Vb			
Gross input		Xa	Xb			

Source: UNCTAD, 2013a.

### 3.1.1. Basic assumptions

Usually, the proportionality assumption is used to allocate imports and exports between the concerned countries. It assumes that the share of imported components in any product intended for domestic consumption as an intermediate product or as part of final demand is the same. Even if it is crucial in construction of an international IOT, the proportionality assumption might be too far from reality for many developing countries, where products destined to export usually contain a higher proportion of imported inputs than those destined for domestic consumption (OECD-WTO, 2012).

According to Koopman et al (2008), this generates a significant overestimation of the domestic value added embodied in exports for countries like China. In order to improve accuracy and reduce the drawbacks associated with the proportionality assumption, researchers at the World Input Output Database<sup>8</sup> first allocate imports according to the categories, i.e. intermediates, final consumption, and investment; and only then they use the proportionality assumption within each category (Timmer, ed, 2012).

Another fundamental assumption used is that the coefficients between the inputs and outputs in the production process are fixed and are referred to as the 'technical coefficients' (Miller and Blair, 2009). For example, if the production of cars worth \$10 billion requires \$1 billion worth

<sup>8</sup> [http://www.wiod.org/new\\_site/home.htm](http://www.wiod.org/new_site/home.htm)

of aluminium as input, the ratio between these numbers (\$1 billion / \$10 billion = 0.1) will provide us with the technical coefficient between aluminium as the input and cars as the output. All subsequent analysis will assume this coefficient will remain unchanged and can be expressed as:

$$a_{kl} = \frac{t_{kl}}{x_l} \quad (2)$$

Where  $a_{kl}$  represents the technical coefficient between inputs from industry  $k$  and outputs from industry  $l$ ;  $t_{kl}$  is the value of inputs from industry  $k$  being used by industry  $l$ , and  $x_l$  represents total output of industry  $l$ . The technical coefficient will allow us to impute the requirement of aluminium to produce a certain output of cars. For example, if we were to produce \$20 billion worth of cars \$2 billion of aluminium would be needed as input, since the technical coefficient was 0.1 in this example. Similarly, import of \$2 billion worth of aluminium from the car industry would imply the production of \$20 billion worth of cars.

In order to obtain a coherent international IOT, important adjustments must be made, which differ depending on the organization constructing the IOT. However, some of the most common are:

- Convert imports expressed in CIF prices (cost, insurance and freight) to FOB prices (free on board), in order to eliminate inconsistencies of mirror trade – discordant data regarding imports and exports between two countries (OECD-WTO, 2012).
- Ensure consistency between imports and exports using different strategies, such as defining exports as mirror flows from imports (Timmer, ed, 2012).
- Ensure consistency of total industrial output by deriving the use of domestically produced goods as the difference between total use and imputed imports obtained using the proportionality assumption (Timmer, ed, 2012).
- Ensure balanced and non-negative values by imposing additional constraints in the data.

### 3.2. Estimating TiVA

The process of TiVA estimation, as presented in the whole section below, is adopted from Koopman et al (2010), Lenzen et al (2013), OECD-WTO (2012), and UNCTAD (2013a). This procedure is given for the purposes of providing technical background and not to introduce an alternative approach.

#### *One-country and G-industry case*

As shown in our single country IOT in figure 5, the gross output of an industry has to be equivalent to the sum of its intermediate and final demand (both domestic and foreign). For an economy, let  $x_k$  be the gross output of industry  $k$ ,  $t_{kl}$  be value of inputs from industry  $k$  being used by industry  $l$ , and  $y_k$  be the net final demand for products from industry  $k$ . We can represent our input output table in the following way (Miller and Blair, 2009),

$$\begin{aligned} x_1 &= t_{11} + \dots + t_{1G} + y_1 \\ \vdots & \quad \vdots \quad \quad \quad \vdots \quad \quad \vdots \\ x_G &= t_{G1} + \dots + t_{GG} + y_G \end{aligned} \tag{3}$$

or

$$\mathbf{x} = \mathbf{T} + \mathbf{y} \tag{4}$$

Where  $\mathbf{x}$  is a  $(G \times 1)$  vector of gross outputs,  $\mathbf{T}$  is a  $(G \times G)$  matrix of *intermediate demand* and  $\mathbf{y}$  is a  $(G \times 1)$  vector of final demand.

We can rewrite (3) and (4) using technical coefficients,  $a_{kl}$ , representing the proportion of inputs industry  $l$  requires from industry  $k$  to produce one unit of output  $l$  in monetary terms, as

$$\begin{aligned} x_1 &= a_{11} x_1 + \dots + a_{1G} x_G + y_1 \\ \vdots & \quad \vdots \quad \quad \quad \vdots \quad \quad \vdots \\ x_G &= a_{G1} x_1 + \dots + a_{GG} x_G + y_G \end{aligned} \tag{5}$$

or

$$\mathbf{x} = \mathbf{Ax} + \mathbf{y} \tag{6}$$

Where  $\mathbf{A}$  is a  $(G \times G)$  *technical coefficient matrix* whose elements are composed of the individual technical coefficients  $a_{kl}$  for each industry. Equation (6) can be solved for  $\mathbf{x}$  as

$$(I-A)x = y$$

$$x = (I-A)^{-1}y$$

$$x = Ly \quad (7)$$

or

$$\begin{pmatrix} x_1 \\ \vdots \\ x_G \end{pmatrix} = \begin{pmatrix} L_{11} & \cdots & L_{1G} \\ \vdots & \ddots & \vdots \\ L_{G1} & \cdots & L_{GG} \end{pmatrix} \begin{pmatrix} y_1 \\ \vdots \\ y_G \end{pmatrix} \quad (8)$$

Where  $L$  is the  $(G \times G)$  *Leontief inverse* and  $I$  is an identity matrix (i.e. ones on the diagonal and zeroes elsewhere). The Leontief inverse can be understood as a total requirements matrix, i.e. a matrix that shows the amounts of gross output required for one unit increase in final demand.

#### *Generalization to N-country (one industry) case*

Further, we generalize the equation (8) to an  $N$ -country and one industry case. The gross output is expressed as the sum of intermediate and final demand (similar to equation (4)), as  $X=T+Y$ , where all are  $(N \times N)$  matrices. Elements of the final demand matrix  $Y$  are  $Y_{ij}$ , which indicates the final demand for products from country  $i$  in country  $j$ . Matrix  $Y$  is thus composed of domestic final demand (diagonal elements,  $i=j$ ), and foreign final demand (off-diagonal elements,  $i \neq j$ ). Similar applies for the total output matrix  $X$ , depending on whether output is destined to domestic industries and domestic final consumers (diagonal elements,  $i=j$ ) or to foreign industries and final consumers (off-diagonal elements,  $i \neq j$ ).

The generalized equation linking the final demand and output for  $N$ -country (one industry) case becomes,  $X=LY$ :

$$\begin{pmatrix} x_{11} & \cdots & x_{1N} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{NN} \end{pmatrix} = \begin{pmatrix} L_{11} & \cdots & L_{1N} \\ \vdots & \ddots & \vdots \\ L_{N1} & \cdots & L_{NN} \end{pmatrix} \begin{pmatrix} y_{11} & \cdots & y_{1N} \\ \vdots & \ddots & \vdots \\ y_{N1} & \cdots & y_{NN} \end{pmatrix} \quad (9)$$

#### *Estimation of TiVA for N-country (one industry) case*

Let us define the share of value added per unit of output by country  $i$ ,  $v_i$ , as the value added in country  $i$ ,  $V_i$ , divided by the total production in country  $i$ ,  $X_i$ . It is equal to one minus the intermediate input share from all countries (including the domestically produced intermediates):



$$v_i = \frac{V_i}{X_i} = 1 - \sum_s A_{is} \quad (10)$$

Where  $V_i$  is the (domestic) value added in country  $i$ , and  $X_i$  is the total output in country  $i$  (both shown in the IOT, see figure 6). Let us place the individual shares of value added  $v_i$  as diagonal elements in a  $(N \times N)$  matrix to obtain the *value added matrix*,  $V$ , of direct domestic value added for all countries (remember that in this case we only have one industry per country).

$$V = \begin{pmatrix} v_1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & v_N \end{pmatrix} \quad (11)$$

Multiplying the value added matrix  $V$  with the Leontief inverse  $L$  will give us the information on how much value added each country needs from its own production and how much from others to reach its current levels of output. The resulting *value added share matrix*,  $M = VL$ , will express the value added requirements in proportional terms. This means, that the underlying international production structure helps us to understand how the value added of all countries is being used.

In the value added share matrix the diagonal elements denote the domestic value added share of domestically produced products; whereas the off-diagonal elements denote the share of foreign value added in production of these same goods. This matrix also contains all the information on how to allocate the domestic share in production and the foreign component. This is then carried out using the gross exports.

Let  $e_{ij}$  be the value of gross exports from county  $i$  to country  $j$ , and  $e_{i*}$  the aggregated gross exports from country  $i$  to all its partners. Then, we can construct the *exports matrix*,  $E$ , by placing the values of exports of country  $i$ ,  $e_{i*}$ , on its diagonal and zeroes off the diagonal:

$$e_{i*} = \sum_{j \neq i} e_{ij} \quad (12)$$

$$E = \begin{pmatrix} e_{1*} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & e_{N*} \end{pmatrix} \quad (13)$$

By multiplying the value added share matrix and the exports matrix we obtain the actual domestic and foreign value added embodied in gross exports, ie. TiVA, as:

$$\hat{T} = VLE$$

(14)

or

$$\begin{pmatrix} \hat{T}_{11} & \cdots & \hat{T}_{1N} \\ \vdots & \ddots & \vdots \\ \hat{T}_{N1} & \cdots & \hat{T}_{NN} \end{pmatrix} = \begin{pmatrix} v_1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & v_N \end{pmatrix} \begin{pmatrix} L_{11} & \cdots & L_{1N} \\ \vdots & \ddots & \vdots \\ L_{N1} & \cdots & L_{NN} \end{pmatrix} \begin{pmatrix} e_{1*} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & e_{N*} \end{pmatrix}$$

(15)

The elements in the TiVA matrix –  $\hat{T}$  – can be interpreted as follows:

- The diagonal elements show the *domestic value added embodied in exports (DVA)*. For example,  $\hat{T}_{11} = v_1 L_{11} e_{1*}$ , represents the value that country 1 needs from itself to produce its exports.
- The off-diagonal column elements represent the *foreign value added embodied in exports (FVA)*. That is,  $\hat{T}_{k1}$  (where  $k \neq 1$ , i.e.  $\hat{T}_{21}$  to  $\hat{T}_{N1}$ ), as so  $\hat{T}_{k1} = v_k L_{k1} e_{1*}$ , denotes the value added that country 1 must import from country  $k$  to generate its exports. By adding all off-diagonal column elements for country 1,  $\hat{T}_{k1}$  (for  $k \neq 1$ , that is excluding  $\hat{T}_{11}$ ), we obtain the total foreign value added (FVA) content of exports of country 1.
- The off-diagonal row elements represent the *indirect value added exports (DVX)*. For example,  $\hat{T}_{1k} = v_1 L_{1k} e_{k*}$ , represents the value added exported by country 1 to country  $k$  and used by country  $k$  to produce its exports. By adding all these elements  $\hat{T}_{1k}$  (for  $k \neq 1$ , that is excluding  $\hat{T}_{11}$ ) we can understand how much of country 1's exports enter as intermediates into third countries' exports.

The above TiVA matrix shows how value added is generated (columns) – domestic (DVA) and foreign value added (FVA) – and how it is distributed (rows) – indirect value added exports (DVX). Since value can only flow between countries, the total value of what each country sources from other countries has to be equal to the total level of value added in exports of other countries, that means that  $FVA = DVX$  on a global level.

The TiVA matrix also links to the total gross exports. The sum of column  $k$  will give the gross exports of country  $k$ ; whereas, the sum of row  $l$  (excluding the diagonal element) will give us the total indirect value added exports (DVX) of country  $l$ , and as such gives a rough estimation for the double counting embedded in the gross trade.

It is worth noting that this estimation shows the content of exports, i.e. domestic/foreign value added embodied in gross exports, and is independent of how the value is used by importers; as opposed to the value added trade, which depends on how a country's exports are used by importers. In order to estimate the latter we would need to balance the value added share matrix with a matrix of final demand, i.e.  $VLY$ , where  $Y$  is the final demand matrix.

### *Generalization to N-country and G-industry case*

The above equation (14) can easily be generalized for  $N$ -country and  $G$ -industry case. Whereby, for each country we have  $G$  industries, resulting in  $(G \times G)$  matrices, which will, in turn, be stacked in block matrices for the  $N$ -country system.

In general, vector and matrix dimensions will change as follows:  $\mathbf{x}$  and  $\mathbf{y}$  become a  $(NG \times 1)$  vectors; the share of value added per unit of output,  $v_i$  becomes a  $(1 \times G)$  row vector, which is put in the diagonal to obtain  $V_i$  as  $(G \times G)$  matrix for each country  $i$ , and hence the value added matrix  $V$  becomes  $(N \times NG)$  matrix; the Leontief inverse for each country pair is  $L_{ij}$  a  $(G \times G)$  matrix, and for the whole system  $L$  is a  $(NG \times NG)$  block matrix; and the export matrix for each country pair is  $E_{ij}$  a  $(G \times G)$  matrix and for the whole system  $E$  becomes a  $(NG \times NG)$  block matrix.

Hence, the TiVA estimate in the case of  $N$ -countries and  $G$ -industries will be a  $(N \times NG)$  matrix, as  $\hat{T} = VLE$ .

### *Decomposition of gross exports (GE)*

Gross exports  $E_{ij}$  of country  $i$  to country  $j$ , can be decomposed into the export of intermediates  $(A_{ij}X_j)$  and the export of final demand  $(Y_{ij})$ . Intermediates can further be decomposed into intermediates processed and absorbed for final consumption in country  $j$   $(A_{ij}X_{jj})$ , intermediates processed in country  $j$  and exported to any third country  $t$   $(A_{ij}X_{jt})$ , and intermediates processed in country  $j$  and exported back to country  $i$   $(A_{ij}X_{ji})$ , obtaining the following decomposition of gross exports:

$$E_{ij} = Y_{ij} + A_{ij}X_j = Y_{ij} + A_{ij}X_{jj} + A_{ij}X_{jt} + A_{ij}X_{ji} \quad (16)$$

Where  $X_{ij}$  is a  $(G \times G)$  matrix of output of country  $i$  used to produce output absorbed in country  $j$ ,  $A_{ij}$  is a  $(G \times G)$  matrix of technical coefficients giving the intermediate use of products from country  $i$  in country  $j$ . Further we aggregate equation (16) over all trade partners of country  $i$  to obtain  $E_{i*}$ , and the basic decomposition of gross exports of country  $i$  to domestic and foreign value added embedded in gross exports, i.e.  $E_{i*} = DVA_i + FVA_i$ , and apply the TiVA equation (14) to the DVA part. This results in the key decomposition equation of gross exports to the sum of the following five elements:

$$\begin{aligned} E_{i*} &= DVA_i + FVA_i \\ (17) \quad &= \underbrace{V_i L_{ii} \sum_{i \neq j} Y_{ij}}_{[1]} + \underbrace{V_i L_{ii} \sum_{i \neq j} A_{ij} X_{jj}}_{[2]} + \underbrace{V_i L_{ii} \sum_{i \neq j} \sum_{t \neq i, j} A_{ij} X_{jt}}_{[3]} + \underbrace{V_i L_{ii} \sum_{i \neq j} A_{ij} X_{ji}}_{[4]} + \underbrace{FVA_i}_{[5]} \end{aligned}$$

The elements of the above equation (17) can be tied to elements in figure 3 interpreted as:

- [1] DVA used for final consumption by importers;
- [2] DVA of intermediates used in importing countries to produce goods and services for final consumption in the importing country;
- [3] DVA of intermediates used in production of goods and services for exports to third countries (DVX);
- [4] DVA of intermediates used for production of goods and services and exported back to the original country (re-imported domestic value);
- [5] FVA embodied in gross exports.

#### 4. Current initiatives in TiVA analysis

At the moment, there are several initiatives aiming at the analysis of GVCs and understanding of their dynamics, inter-industry trade, and trade in value added. Some of these initiatives are focusing on obtaining regional and multi-regional IOTs, which are the basis for TiVA estimation. There are also a couple of initiatives in estimating TiVA. Table 2 makes an

overview of the databases of international and regional IOTs, and summarizes the two currently available TiVA databases.

**Table 2: List of international IOT databases**

<b>Project<sup>9</sup></b>	<b>Institution</b>	<b>Data years</b>	<b>Total number of economies included</b>	<b>ESCAP Members and Associate Members included<sup>10</sup></b>
STAN Input-Output Database	OECD	1990-2009	48	14
Asian International Input-Output Table	IDE-JETRO	1975-2005 (every 5 years)	10	9
Global Trade Analysis Project (GTAP)	Purdue University	2004, 2007, 2011	140	29
World Input-Output Database (WIOD)	European Commission (funded)	1995-2009	40	6

Sources: OECD, 2012; IDE-JETRO, 2005; GTAP, 2012; Timmer, ed, 2012.

**Table 3: List of TiVA databases**

<b>Project</b>	<b>Institution</b>	<b>Data years</b>	<b>Total number of economies included</b>	<b>ESCAP Members and Associate Members included</b>
UNCTAD-Eora GVC Database <sup>11</sup>	UNCTAD and University of Sydney	1990-2011	187	44

<sup>9</sup> Details of some databases will vary based on the version/edition.

<sup>10</sup> List of ESCAP Member States and Associate Members can be obtained at: <http://www.unescap.org/about/member-states>. In 2015 there are 53 Member States and 9 Associate Members of ESCAP; however, 4 of the Member States are not in the Asia-Pacific region, namely France, Netherlands, United Kingdom, and United States of America. These four non-regional ESCAP Member States are not included in the analysis.

<sup>11</sup> We will refer to the analysis made by UNCTAD (2013a, 2013b), which is based on the Eora MRIO database, as UNCTAD-Eora database for convenience only.

OECD-WTO TiVA Database	OECD-WTO	1995, 2000, 2005, 2008, 2009	57	17
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Source: UNCTAD, 2013a; OECD-WTO, 2013a.

#### 4.1. OECD and WTO

The OECD developed a global IOT, which currently includes public data for 48 economies. This global IOT is mainly focused on the OECD member countries, which from the ESCAP region are Australia, Japan, New Zealand, Republic of Korea and Turkey. It also includes a limited number of other non-OECD countries, which among regional ESCAP economies includes: Cambodia, China, India, Indonesia, Malaysia, Russian Federation, Singapore, Thailand and Viet Nam (OECD, 2012).

In May 2013, the OECD-WTO Trade in Value-Added database was released, presenting indicators for 57 economies and broken down by 18 industries. It includes the decomposition of gross exports by industry into their domestic and foreign contents; the services content of gross exports by exporting industry (broken down by foreign/domestic origin); bilateral trade balances based on flows of value added embodied in domestic final demand; and intermediate imports embodied in exports. This database includes 17 of the regional ESCAP economies: Australia, Brunei Darussalam, Cambodia, China, India, Indonesia, Japan, Malaysia, New Zealand, Philippines, Republic of Korea, Russian Federation, Singapore, Thailand, Turkey, Viet Nam, and Hong Kong, China (OECD-WTO, 2013a).

The OECD-WTO TiVA database incorporates more than twenty different indicators of value added embodied in global trade. Nonetheless, the data presents some limitations, such as timeliness, as the latest time period is 2009, and geographical coverage, as it incorporates only 17 out of the 58 regional ESCAP economies.

#### 4.2. UNCTAD and Eora MRIO

The United Nations Conference on Trade and Development (UNCTAD) in collaboration with the Eora Project,<sup>12</sup> which developed a Multi-Region Input-Output (MRIO) database, estimated

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<sup>12</sup> The Eora Project, originally funded by the Australian Research Council, based at the University of Sydney and comprising an international team of researchers, developed the so-called “world multi-region input-output (MRIO) database” that is the basis for the generation of the value added trade estimates in the GVC Database discussed in this paper. For further details, see <http://www.worldmrio.com/>.

TiVA indicators for most economies in the world (Lenzen et al, 2012, Lenzen et al, 2013). This database was first published in the “Global Value Chains and Development” report (UNCTAD, 2013a), which introduced some initial findings with regards to participation in GVCs; subsequently it was also referred to in the 2013 World Investment Report (UNCTAD, 2013b).<sup>13</sup>

The Eora dataset provides input-output tables for 187 individual economies and 15,909 sectors; it has a continuous coverage for 22 years (from 1990 to 2011) and it provides a series of indicators on trade and environment issues (Lenzen et al, 2013). The dataset fully covers 4 out of 5 ESCAP sub-regions (East and North-East Asia, South-East Asia, South and South-West Asia and North and Central Asia), with some gaps in the Pacific subregion. Out of ESCAP's 58 regional Members and Associate Members, 44 are covered. The 14 economies not considered all belong to the Pacific subregion.

In order to estimate the Eora MRIO, researchers from the University of Sydney followed the procedure shown below (Lenzen et al, 2012, Lenzen et al, 2013):

1. Collection of national supply and use tables or national input-output tables when the former were not available. The aim was to obtain information on the goods and services produced by each domestic industry and their use by another industries or a final user.
2. Link SUTs or IOTs through international trade statistics using import tables to obtain a MRIO table.
3. Balance the MRIO such that the total output produced by each industry equals the sum of inputs (including value added).

The creators of the Eora MRIO faced many challenges, the most important being the lack of information from small economies. In order to deal with this issue, different assumptions were used to impute the missing data. However, balancing the information for 187 economies signified an additional burden that was dealt with by using refined econometric models.

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<sup>13</sup> UNCTAD does not release the database. The Eora MRIO project make the database free for academic (university or grant-funded) work at degree-granting institutions. All other uses require a data license before the results are shared (<http://worldmrio.com/license.jsp>).

### 4.3. Other initiatives

The World Input-Output Database (WIOD) is one of the initiatives to obtain international IOTs. It is funded by the Research Directorate General of the European Commission and covers 27 EU countries and 13 other economies from 1995 to 2009 (Timmer, ed, 2012). However, only six regional ESCAP economies are covered, i.e. Australia, China, India, Indonesia, Republic of Korea and the Russian Federation. The WIOD does not estimate TiVA, but the intentional IOT could be used for its estimation.

Recently, IDE-JETRO released their 2005 Asian IOT, which includes nine regional ESCAP countries, i.e. China, Indonesia, Japan, Malaysia, the Philippines, Republic of Korea, Singapore, and Thailand. It gives a picture of input composition and output distribution of each domestic industry vis-à-vis home and foreign industries. Note that many less developed and smaller economies in the region are left out. IDE-JETRO also does not provide estimates of TiVA, but it could be estimated from the IOT (IDE-JETRO, 2005).

The Global Trade Analysis Project (GTAP), coordinated by the Centre for Global Trade Analysis at Purdue University, focuses on bilateral trade, production, consumption and use of intermediate goods and services. The different versions of the GTAP database are considered consistent representations of the world economy; they are created using national IOTs as well as trade data from other sources. The latest version, GTAP data base 9, includes 29 of the regional ESCAP economies. TiVA is not estimated but could be obtained using this database (GTAP, 2012).

Working with national statistical offices and developing their capacity in the construction of SUTs and/or IOTs may be the best approach to improve the measurement of trade in value added. In this regard, the ADB started a regional technical assistance program (RETA) at the end of 2008.<sup>14</sup> They worked with 18 economies in the Asia-Pacific region to develop sufficient technical assistance, appropriate methodology, and specific solutions for each economy, and resulted that all economies successfully completed their SUTs. To build on the outcomes of the previous project and to update the SUTs of the participating economies, ADB initiated a new technical assistance project in 2014.<sup>15</sup>

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<sup>14</sup> For more information see: <http://www.adb.org/data/icp/reta-6483>.

<sup>15</sup> For more information see: <http://www.adb.org/sites/default/files/project-document/152171/48387-001-tar.pdf>



The Asia-Pacific Economic Cooperation (APEC) has a project entitled Strategic Framework on Measurement of APEC TiVA under GVCs. It aims at measuring TiVA and understanding its policy implications with regards to trade, investment, employment, etc. The enhanced measurements would be used to facilitate the implementation of APEC Recommendations on Promoting GVCs Development and Cooperation, encouraging the liberalization of trade and investment. They will closely work with other international organizations and the existing databases, mainly the OECD-WTO database. During 2015-2017, APEC will prepare and unify standards and work on training and capacity building to start the compilation of APEC IOTs. The compilation process will be undertaken in collaboration with the OECD-WTO and is expected to be finalized by 2018 (APEC, 2014).

## **5. TiVA analysis for selected ESCAP economies**

In this section we present an initial TiVA analysis for the regional ESCAP Members States and Associate Members<sup>16</sup> that are included in the two main data sources available.

### **5.1. Description of the data sources**

In this analysis we use data from the OECD-WTO TiVA database<sup>17</sup> and analysis made by UNCTAD (2013a, 2013b), which is based on the Eora MRIO database (Lenzen et al, 2012 and Lenzen et al, 2013), to which we will refer as the UNCTAD-Eora database for convenience only.

Out of the 58 regional ESCAP economies, 17 are included<sup>18</sup> in the OECD-WTO TiVA database, which represent approximately 95% of both the region's GDP and total exports of merchandise in 2009. On the other hand, the UNCTAD-Eora database includes 44 of the regional ESCAP economies. However, the detailed datasets for individual economies of only OECD-WTO are available to ESCAP so the extent to which we can compare information between the sources is limited.

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<sup>16</sup> List of ESCAP Member States and Associate Members can be obtained at: <http://www.unescap.org/about/member-states>. In 2015 there are 53 Member States and 9 Associate Members of ESCAP; however, 4 of the Member States are not in the Asia-Pacific region, namely France, Netherlands, United Kingdom, and United States of America. These four non-regional ESCAP Member States are not included in the analysis.

<sup>17</sup> Accessible at: <https://stats.oecd.org/index.aspx?queryid=47807>

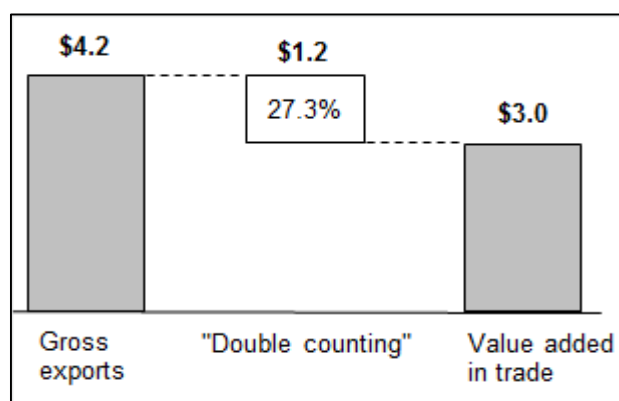
<sup>18</sup> The 17 economies included are: Australia, Brunei Darussalam, Cambodia, China, India, Indonesia, Japan, Malaysia, New Zealand, Philippines, Republic of Korea, Russian Federation, Singapore, Thailand, Turkey, Viet Nam, and Hong Kong, China.

Fourteen of the economies analysed are included in both of the sources. An initial comparison of the results obtained from these databases in terms of the shares of domestic value added in gross exports shows a high similarity between the results. The OECD-WTO and UNCTAD-Eora results are similar for most economies, with two important exceptions: Singapore and Hong Kong, China. The OECD-WTO database estimates Hong Kong, China's share of domestic value added in gross exports to be 72%, whereas the UNCTAD-Eora database estimates it to be only 46%; in the case of Singapore the OECD-WTO estimates the share of domestic value added of 50%, compared to 36% estimated by UNCTAD-Eora. The significant differences with respect to the domestic value added in the cases of Hong Kong, China and Singapore could be due to the measurement of value added of services. Both economies are traditional places for trade (i.e. economies where merchandise is imported and then re-exported at higher prices) and the extent to which this importing and re-exporting is accounted as a services value added could make a significant difference in the results.

## 5.2. Regional TiVA

Based on the OECD-WTO trade data the 17 regional ESCAP economies included in the analysis produced total of \$4.2 trillion in gross exports in 2009 (exports of goods and services minus re-exports), but the domestic value added (DVA) embodied in the gross exports of these economies was approximately \$3.0 trillion, which is 72.7% of gross exports. The difference between total gross exports and value added embodied in gross exports (DVA), which represents the foreign value added embodied in gross exports (FVA), could be attributed to double counting, as shown in figure 7. This means that the level of double counting in gross exports for the 17 regional economies is 27.3% of their gross exports in 2009, which is very similar to the global estimate of 28% in 2010 made by UNCTAD (2013a).

**Figure 7: Disaggregation of gross exports for 17 ESCAP economies in Asia-Pacific, 2009 in trillion US\$**

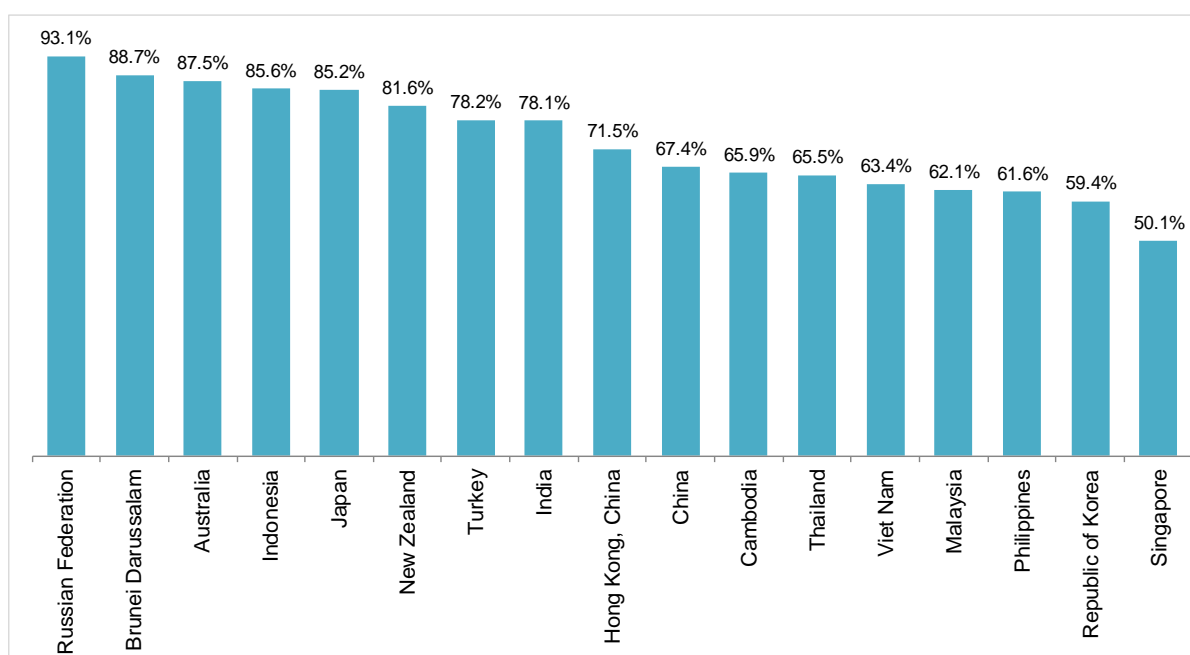


Source: OCDE-WTO, 2013a.

Detailed analysis reveals large variation between individual economies. The domestic value added in gross exports ratio, also referred to as the “export ratio,” shows the percentage of domestic value added embodied in gross exports as a share of total gross exports of that economy. It is expected that the size of the economy, the composition of its exports, and its economic structure and export model determine the domestic value added in gross exports (UNCTAD, 2013a).

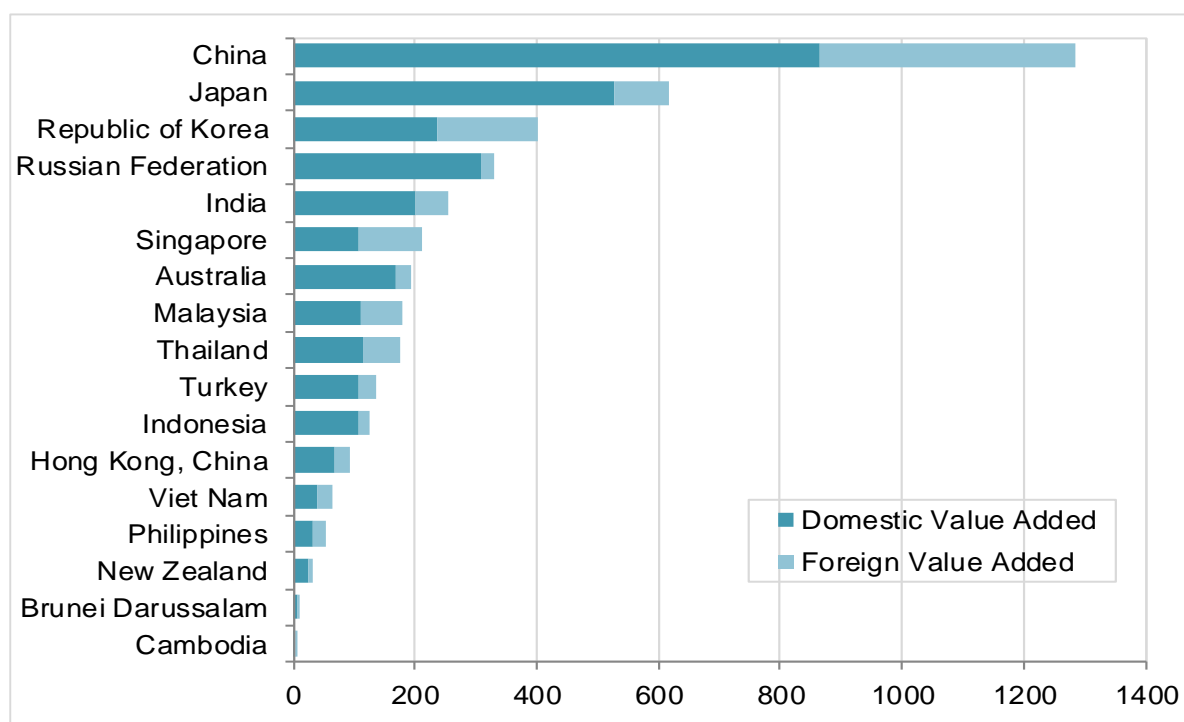
Larger economies tend to have longer national value chains and thus present higher levels of domestic value added; exporters of services and commodities/raw materials need few foreign inputs and thus present higher share of domestic value added in gross exports. This is further supported with data as shown in figure 8. We can see that economies exporting large amounts of natural resources, such as Australia, Brunei Darussalam and Russian Federation, exhibit higher domestic value in gross exports. Larger economies with developed internal value chains, such as Japan, and economies that rely mostly on services, such as India, also exhibit high levels of domestic value added relative to gross exports. On the other hand, economies which are heavily involved in global value chains and require high imports of intermediate goods and services, such as Singapore, present lower shares of domestic value added in their gross exports. China is clearly the largest merchandise exporter in the region, but a significant share of its exports depends on imported intermediates and raw materials from abroad. The disaggregation of gross exports for the economies analysed can be seen from figure 9, which shows the values of the domestic and foreign value added embodied in gross exports.

**Figure 8: Shares of domestic value added in gross exports, 2009**



Source: OECD-WTO, 2013a.

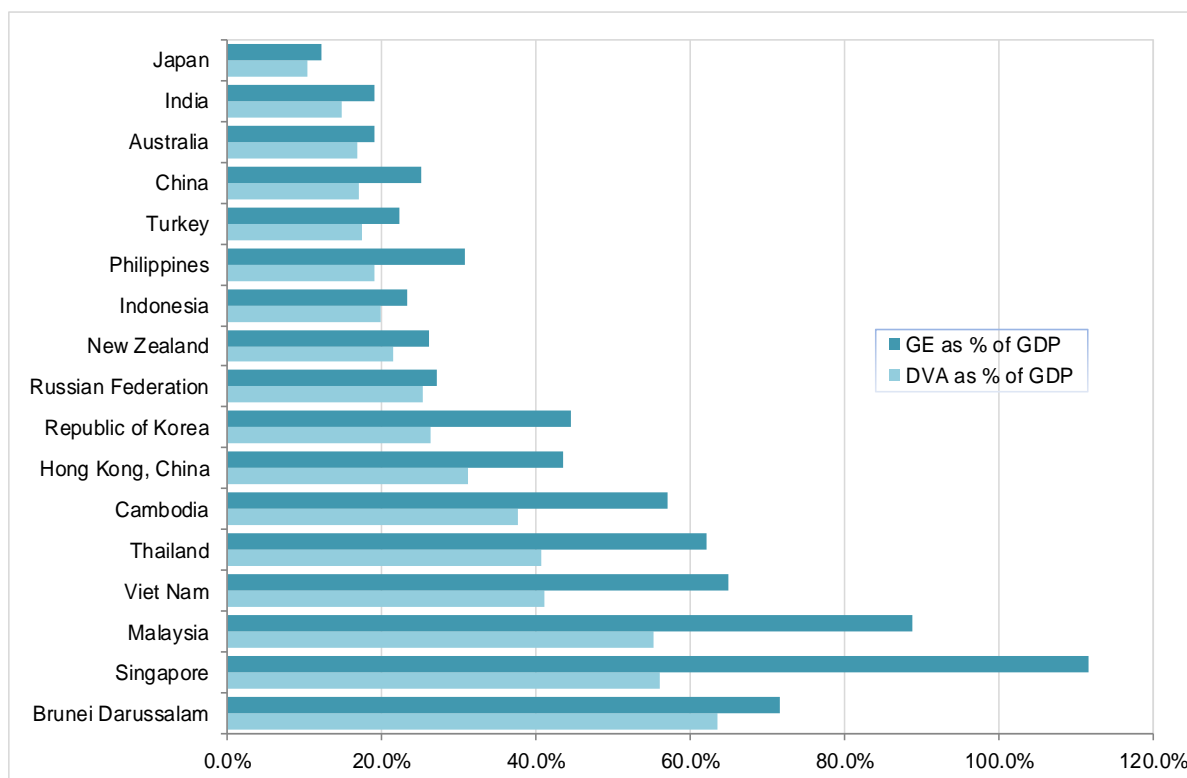
**Figure 9: Values of the domestic and foreign value added embodied in gross exports, 2009 in billion US\$**



Source: OECD-WTO, 2013a.

From figure 10 we can see the contribution of trade to GDP of the 17 regional ESCAP economies included in the analysis, both from gross exports perspective and from the value added perspective, through DVA. The highest DVA as a percentage of GDP can be observed for Brunei Darussalam, Malaysia, and Singapore. The latter two also have the highest percentage of total exports in their GDP. These economies are highly dependent on exports and in particular Brunei Darussalam and Malaysia are also highly dependent on exporting natural resources. On the other hand, the lowest percentages are in less export dependant economies, such as Australia, India and Japan. In the case of Cambodia, Thailand and Viet Nam we can see that gross export accounts for high shares of their GDP, but in comparison the DVA-based ratios are significantly lower. This can be attributed to their participation in GVCs in the manufacturing industries, rather than in export of natural resources.

**Figure 10: Domestic value added (DVA) and gross exports (GE) as a percentage of GDP, 2009**



Source: OECD-WTO, 2013a (DVA) and ESCAP, 2015 (GDP).

### 5.3. TiVA by industry<sup>19</sup>

Analysis by industry also reveals substantial differences between industries at the regional level. Industries devoted to the exploitation of natural resources, agriculture and retail trade have generally higher domestic value added in gross exports ratios, whereas manufacturing industries have in general lower ratios. Table 4 presents these ratios for the industries presented in the OECD-WTO database for the 17 regional ESCAP economies included in the analysis.

**Table 4: Domestic value added in gross exports ratios by industry, 2009**

Industry	Domestic value added in gross exports ratio (%)
Agriculture, hunting, forestry and fishing	87.1
Mining and quarrying	91.2

<sup>19</sup> A similar analysis was already published in the Asia-Pacific Trade and Investment Report 2014 (ESCAP, 2014a).

<b>Industry</b>	<b>Domestic value added in gross exports ratio (%)</b>
Food products, beverages and tobacco	81.4
Textiles, textile products, leather and footwear	76.5
Wood, paper, paper products, printing and publishing	75.5
Chemicals and non-metallic mineral products	65.3
Basic metals and fabricated metal products	72.3
Machinery and equipment, nec	71.4
Electrical and optical equipment	59.4
Transport equipment	74.6
Manufacturing nec; recycling	69.8
Electricity, gas and water supply	86.0
Construction	77.1
Wholesale and retail trade; Hotels and restaurants	86.4
Transport and storage, post and telecommunication	77.0
Financial intermediation	85.8
Business services	83.8
Other services	88.6
<b>Total</b>	<b>72.8</b>

Source: OECD-WTO, 2013a.

This further shows the manufacturing sector's involvement in GVCs. Intermediate products are often traded between economies in several stages, and each stage adds a part of the total value added of these products. Hence, the domestic value added at each stage is smaller for these industries.

Further, we look at comparison between two economies with different export structures, namely Australia and China. Table 5 presents the percentages of each industry in total gross exports and the share of domestic value added in gross exports for each industry both for Australia and China. China is mainly oriented towards exports of manufactured goods, such as electrical and optical equipment, whereas Australia is generating most of the exports from natural resources. As a result the overall domestic value added to gross exports ratio for Australia is larger than for China; or in other words, Australia exports more of its own domestic value added than of the value added that it imports.

**Table 5: Each industry as a percentage of gross exports (GE) and their domestic value added (DVA) to gross exports (GE) ratios for Australia and China, 2009**

Industry	Australia		China	
	Percentage in GE	DVA to GE ratio	Percentage in GE	DVA to GE ratio
Agriculture, hunting, forestry and fishing	4.3	96.1	6.4	86.1
Mining and quarrying	33.4	90.9	8.0	34.8
Food products, beverages and tobacco	3.2	97.7	1.8	87.9
Textiles, textile products, leather and footwear	0.5	82.3	6.9	92.6
Wood, paper, paper products, printing and publishing	1.4	81.5	2.7	70.8
Chemicals and non-metallic mineral products	3.8	67.3	10.6	67.1
Basic metals and fabricated metal products	7.5	80.9	7.3	71.4
Machinery and equipment, nec	1.5	73.0	4.0	73.8
Electrical and optical equipment	1.6	57.1	15.1	65.1
Transport equipment	1.3	79.5	2.1	74.0
Manufacturing nec; recycling	0.4	80.7	3.3	83.1
Electricity, gas and water supply	1.5	85.2	2.3	73.3
Construction	1.5	94.7	0.3	29.9
Wholesale and retail trade; Hotels and restaurants	7.4	82.8	10.3	73.9
Transport and storage, post and telecommunication	10.9	89.1	4.7	53.6
Financial intermediation	4.3	88.3	4.4	73.7
Business services	12.5	90.0	7.8	41.1
Other services	3.2	91.6	2.0	70.4
<b>Total</b>	<b>100.0</b>	<b>87.5</b>	<b>100.0</b>	<b>67.4</b>

Source: OECD-WTO, 2013a.

From this we can also conclude that Australia participates much more in the early stages of GVCs and that much of the value added is generated from activities that are at the beginning of the value chain, i.e. mining and quarrying activities. On the other hand, China participates in the middle or late stages of GVCs, which means that it imports significant proportion of foreign value added for further processing. Hence, the domestic value added in China's exports in percentage terms will be lower.

#### **5.4. TiVA analysis of services contribution to exports<sup>20</sup>**

One of the advantages of the TiVA analysis is that it allows us to estimate the role of services in trade. Such analysis might be important due to the effect of servicification, which has not been properly addressed in the policy discussions due to the lack of data. In this regard, the shares of domestic and foreign value added from services in gross exports are important indicators.

Services are an important part of trade. In 2009, the total domestic value added of services represented 27.0% of the gross exports of the 17 regional ESCAP economies included in the OECD-WTO analysis and the total value added trade in services (domestic plus foreign value added embodied in exports) accounted for 37.4% of gross exports. In general, the share of services trade in total trade is relatively higher when measuring in value added terms compared to traditional measure (Johnson, 2014). This is mainly due to two reasons, gross exports of merchandise includes value added from services sector, which is stripped out in value added terms; and trade in services is less vertically specialized, which means that export of services includes less imported foreign value added.

GVCs in Asia-Pacific have significantly contributed to an increased servicification among the developing economies in the region. In general, domestic sourcing of services remains dominant, especially in agricultural and mining sectors; however, the shares of imported services in industrial exports have been rising, particularly in the case of business services. The shares of intraregional imports of services have also seen an increase (Anukoonwattaka et al, 2015).

In figure 11 we can see both shares of total domestic services and the share of indirect domestic services in gross exports. High percentage of the indirect contribution of domestic service suppliers reflect that service industries participate through domestic (upstream)

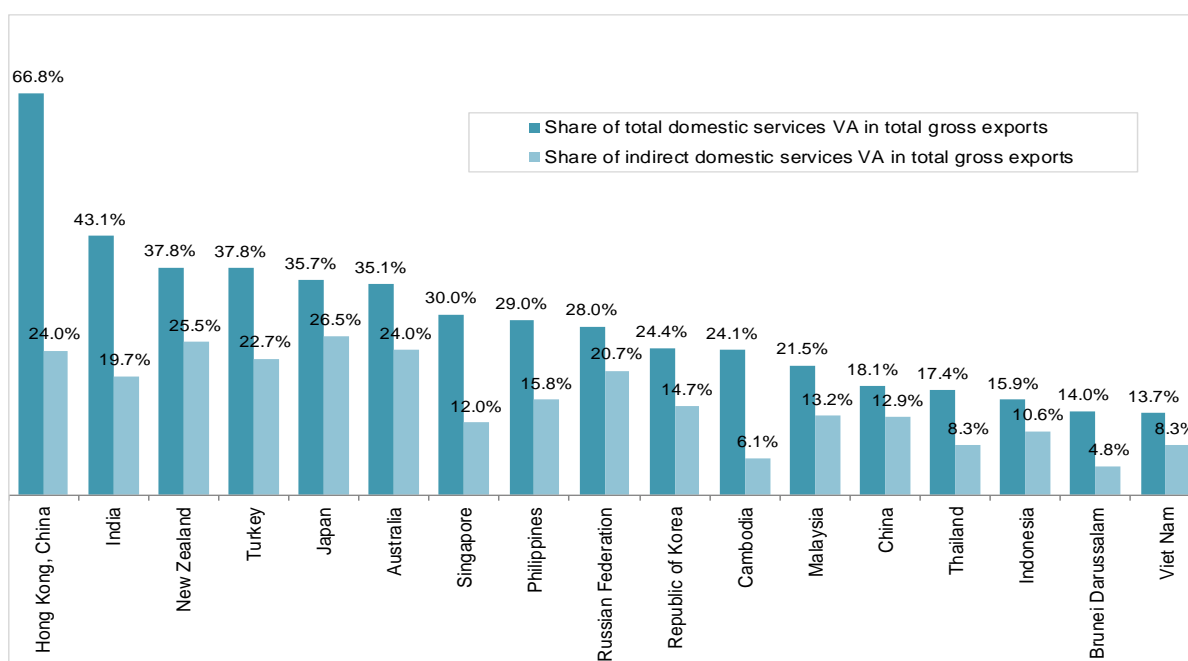
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<sup>20</sup> For a more detailed analysis on services see Anukoonwattaka et al, 2015; and ESCAP, 2014a.



transactions in exports of that economy, and under traditional measurement of trade this would show as export of merchandise. The shares of indirect domestic services value added in gross exports are large in comparison to the total percentage of services in gross exports especially for large manufacturing economies, such as China and Japan, as much of domestic services industries are supporting manufacturing of goods for export. On the other hand, for economies that rely on export of services, such as the Philippines, Singapore, and Hong Kong, China, the percentage of direct services value added in exports is much larger.

**Figure 11: Total domestic value added of services and indirect domestic services as a share of gross exports, 2009**



Source: OECD-WTO, 2013a.

## 5.5. Participation in GVCs

The UNCTAD (2013a) analysis shows that the East and Southeast Asia (as defined by UNCTAD) is the subregion<sup>21</sup> with the highest levels of participation in GVCs due to its important share in manufacturing and processing activities. South Asia, on the other hand, appears as the lowest ranked subregion in terms of GVC participation.

As introduced in section 0, GVC participation is calculated as the sum of foreign value added embodied in gross exports (upstream component) and the domestic value added embodied

<sup>21</sup> This UNCTAD subregion covers two ESCAP subregions: East and North-East Asia and South-East Asia.

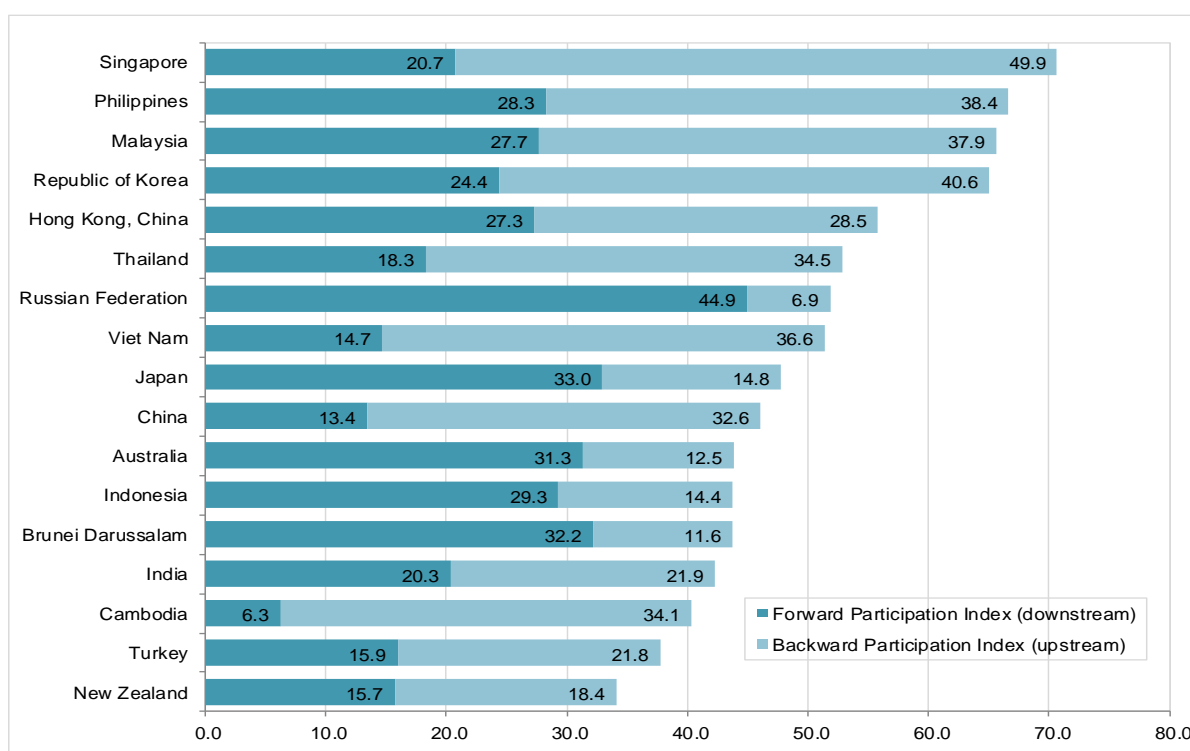
in other economies' exports (downstream component). Therefore, two regions with similar levels of GVC participation may present very different trade dynamics, depending of the size of their upstream and downstream components.

As a subregion, East and South-East Asia exhibits a very balanced upstream versus downstream participation. Economies in the region are both importing and exporting intermediate goods, and they are developing strong regional and global value-chains. In contrast, South Asia shows a stronger downstream component in their GVCs (UNCTAD, 2013a).

Countries, such as China, Philippines, and Thailand, all have both increased their involvement in GVCs and reduced their dependence on foreign inputs, thus raising the value added of their exports. These countries increased their integration into GVCs by participating in industries that allow for separate components to be easily traded, such as the automotive and the electronics industries, and at the same time they developed national production chains that increased the value of national components in their exports (UNCTAD, 2013a).

From figure 12 we can see the backward and forward GVC participation indices for the 17 ESCAP economies included in the OECD-WTO dataset. Malaysia, Philippines, Republic of Korea, and Singapore have the highest GVC participation rates; however, they also have higher proportion of backward participation (upstream component). This means that their participation in GVCs results in proportionately large import of foreign value added. Conversely, Australia, Brunei Darussalam and the Russian Federation have a proportionately high forward participation, resulting in exports of domestic value added being dominant. The latter can be attributed to the exports of natural resources, which have large amounts of domestic value added components.

**Figure 12: Forward and backward GVC participation indices, 2009**



Source: OECD-WTO, 2013a.

## 6. Conclusion

The analysis shows that TiVA is a very useful concept for objective measurement of trade and can help formulate better industry and trade policies. Trade, in general, represents a significant share of an economy's GDP and as such can stimulate economic development. In recent years, trade flows are becoming more and more complex and harder to analyse. That is partly due to the development of GVCs and the increased participation of developing economies in GVCs, which generate trade of intermediate goods and services between economies for further processing. As a result of this high number of trade transactions with intermediate goods, trade statistics do not provide answers to how much value is actually produced in a certain economy.

The concept of TiVA reveals the actual value of components in trade of every partner economy participating in GVCs. It allows us to understand how much of the final value of the product is added at each step of global production; it also reveals how much foreign value each economy passes through its imports, and allows us to measure each economy's participation in the GVCs.

Basic analysis for the selected ESCAP economies shows that the shares of domestic value added in gross exports are between 50% and 95%, and that in general the domestic value added as a percentage of gross exports in manufacturing industries is lower than the one in service industries. Economies that rely on trade in natural resources or agricultural products have higher domestic value added in their exports, whereas economies engaging in production and processing activities import a significant proportion of the value added for further processing; hence, the domestic value added by these economies is lower in proportion. Such information is crucial for policy makers to decide on policies to stimulate trade and industries which have the highest potential to stimulate domestic production and generate employment.

There are several challenges that persist in the measurement of TiVA. The absence of adequate SUTs and/or IOTs severely limits the availability and accuracy of value added estimates. Additionally, it is worth mentioning some of the other challenges in measurement of TiVA:

- Lack of statistical capacity: Constructing and updating SUTs/IOTs is resource demanding on the national statistical system and many economies in the region do not have the statistical capacity to produce these tables. Hence, significant investment still needs to be made in statistical capacity before TiVA estimates become more inclusive.
- Inclusiveness: Many economies in Asia-Pacific are not included in the current regional/international IOTs. In order to have a comprehensive TiVA estimate, we need to make sure all economies and trading partners are included.
- Timeliness: In many cases the SUTs/IOTs might not be updated very regularly, therefore, TiVA estimates may be outdated by the time they are released. For example, the last time period available in the OECD-WTO database is 2009, but between 2009 and 2015 exports of merchandise by the regional ESCAP economies grew by 62% and Asia-Pacific became the world's largest trading region.
- Validity of assumptions: Estimation of the TiVA, as described above, requires several assumptions. As a result, these assumptions may not necessarily reflect the real structures of their industrial and services sectors, or might be wrong.

- Procedure standardization: At the moment there is no internationally agreed standard for estimating TiVA. There are several procedures developed by researchers, but development of an international standard would help the reliability and comparability of estimates.
- Open data: Allowing public access to tables and databases should help increase confidence and usability of TiVA estimates.

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