POLICY BRIEF NO. 3

PERFORMANCE OF COMPUTER, ELECTRONICS AND OPTICAL PRODUCTS IN POST-ITA PHASE:

SOME INSIGHTS FROM OECD TiVA DATABASE

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A. INTRODUCTION

Information technology (IT) products, including computers, telecommunication equipment, semi-conductors etc., is one sector in which much of the international trade is undertaken duty-free. This is a result of the main players in this sector participating in two agreements at the World Trade Organisation (WTO) - the Information Technology Agreement (ITA) and the expansion of the ITA (popularly referred to as ITA-2). The Information Technology Agreement (ITA) sought to enhance global trade in IT products by mandating the WTO members participating in the agreement to eliminate and bind customs duties on specified IT products at zero. The relevance of ITA/ITA-2 is heightened by a recent development among some WTO members. Under the Joint Statement Initiative (JSI), about 80 members of the WTO are negotiating rules on electronic commerce. While these negotiations involve a large number of issues, an attempt is also being made to get some of the countries which had kept themselves out of ITA/ ITA-2 to join these agreements. Countries that are not participants in ITA/ITA-2 might benefit from the experience of countries that are participating in ITA/ITA-2. This provides the relevance of seeking to understand how the IT hardware industry has evolved in some of the countries that are participating in ITA/ITA-2.

Launched at the Singapore Ministerial Conference of the WTO in December 1996, the ITA came into force in July 1997. Starting with 29 WTO members as the initial participants, the ITA now has 81 signatories. They account for approximately 97 per cent of world trade in IT products. The ITA covers a large number of high technology products, including computers, telecommunication equipment, semi-conductors, semi-conductor manufacturing and testing equipment, software, scientific instruments, as well as most of the parts and accessories of these products. The ITA-2, which was agreed at the Nairobi Ministerial Conference in December 2015, covers software and digital content; photographic or cinematographic products, touch screens, GPS navigation equipment, video game consoles, portable interactive electronic education devices, etc**.**

As the tariff concessions under ITA and ITA-2 are included in the participant's WTO schedules of concessions, the tariff elimination is implemented on a most-favoured-nation (MFN) basis. Thus, even countries that have not joined the ITA can benefit from the trade opportunities generated by ITA tariff elimination.[1] Brazil is the only country among the top twenty economies by GDP that has opted to remain outside the ITA. However, in addition to Brazil, India and Indonesia have also chosen not to become a participant of ITA 2. Table 1 provides details of participation in ITA and ITA-2 by the countries examined in this study.

There is considerable evidence to suggest that these two agreements have been accompanied by a substantial increase in international trade in IT products - both parts and components and final products. Bora and Liu (2006)[2] provide an empirical assessment of the ITA under a gravity model framework. Their results show that all other things remaining equal, an ITA member would import at least 7% more in ITA products if the exporter is a WTO member compared to a baseline case of neither being a member of the WTO. Parayil and Joseph (2006) postulate that the ITA could be instrumental in attracting investment into the ICT sector because of the direct link between trade and investment[3]. While tariff reduction and increased competition associated with trade liberalisation could bring down the prices of ICT goods and services, Mann and Liu (2009)[4] conclude that

the price elastic property of ICT products could be an impetus for greater demand and market access. On the basis of an analysis of the performance of IT trade during 12 years after the inception of the ITA, Anderson and Mohs (2010)[5] highlight the changing composition of a trade by leading exporting and importing nations and the changing profile of ITA trade by different product segments.

Table 1: Participation by WTO members in ITA and ITA-2

Member	Average bound rate of ITA products before the economy joined ITA	Date of initiation of tariff reduction/elimination under ITA	Date of completion of tariff elimination under ITA	Whether Member of ITA - 2
Germany	1.00	26-Mar-97	01-Jan-00	Yes
Japan	0.17	26-Mar-97	01-Jan-00	Yes
Korea	4.33	26-Mar-97	01-Jan-05	Yes
United Kingdom	1.00	26-Mar-97	01-Jan-00	Yes
United States	0.53	26-Mar-97	01-Jan-00	Yes
Argentina	34.16	Not a Member	No Schedule	No
Brazil	31.14	Not a Member	No Schedule	No
China	1.33	24-Apr-03	Acceded	Yes
India	17.77	26-Mar-97	01-Jan-05	No
Indonesia	39.44	26-Mar-97	01-Jan-05	No
Malaysia	12.69	26-Mar-97	--	Yes
Turkey	3.57	26-Mar-97	01-Jan-00	Yes
Singapore	0.96	05-Aug-97	01-Jan-00	Yes
Thailand	5.89	30-Jan-98	01-Jan-05	Yes
Vietnam	3.80	27-Oct-08	01-Jan-14	No

Source: WTO, TAO

Ezell (2012)[6] has argued that the ITA has been one of the most successful trade agreements ever undertaken as it played an important role in expanding global trade in ICT products leading to innovation, enhanced productivity, increased employment, and accelerated economic growth. According to this study, the ITA and ITA-2 benefit developing countries in "three principal ways: 1) reducing tariffs on a broader range of ICT products encourages greater adoption of ICT products that play a key role in spurring economic growth; 2) lower prices realised by reducing tariffs on ICTs increases the productivity of all other industries in a developing economy; and 3) by lowering the price of key input, the ITA has undergirded the

development of the burgeoning ICT software and services industries in many developing countries such as India, Indonesia, Malaysia, and the Philippines."

Many studies on ITA have focused on its likely *future* economic impact on the participating countries. However, few studies have examined the economic performance of the domestic producers of IT goods *after* these countries implemented the obligations under the agreement. Did the increase in imports of parts and components at internationally competitive prices enhance domestic competitiveness, thereby resulting in a substantial increase in domestic production and exports of value-added downstream products? In the absence of tariff protection, were the domestic producers of parts and components and final products able to successfully face import competition? Did duty-free imports of final products in the IT sector displace the domestic players? Did the availability of IT hardware imported duty-free spur exports of IT Services from the country? These questions continue to remain unanswered, despite the ITA having been implemented by many countries for almost two decades.

Although there are many studies on trade trends in ITA products, is there any fundamental reason why there has been a little empirical examination of the performance of IT hardware industry in countries participating in the ITA? Perhaps the absence of data on production and domestic value-addition on a comparable basis across countries might explain this dichotomy. Availability of disaggregated trade data for most of the products within the scope of ITA and ITA-2 explains why it is not difficult to analyse the trade performance of countries pre-and post these agreements. However, for most of the countries participating in these agreements, it is almost impossible to find reliable disaggregated data on production, amount of domestic value-addition and imported content in the manufacture of the products covered by the two agreements.

As a second-best option, the economic performance of domestic producers of IT hardware could be assessed not at a disaggregated product level, but at an aggregated sector level. However, even this option for analysing the performance of domestic IT hardware industry is not free from constraints, as reliable data on value-addition created through domestic production is

hard to come by. One option could be to use Input-Output tables (I-O tables) for this purpose. I-O tables are designed to measure the interrelationships between the producers of goods and services (including imports) within an economy and the users of these goods and services (including exports). This provides a detailed view of domestic and imported intermediate inputs and final products used at sectoral level in an economy-wide framework. I-O tables can be used to estimate the contribution that imports make in the production of any good (or service) for export. However, using I-O tables for each country separately prevents meaningful comparison across countries.

Using detailed estimates of value-added created in different sectors and different countries as contained in two different editions of the OECD database on Trade in Value-Added (TiVA), the present study seeks to make a modest contribution in understanding how the domestic IT hardware industry has performed in different countries after implementation of the ITA. At the heart of the study is the concept that the goods and services which consumers buy are composed of inputs from various countries and industries around the world. The study uses value-added created by the product category "Computer, Electronics and Optical Products" (hereinafter referred to as "CEO products") as the basis for seeking to answers to the following questions: first, which countries are the main exporters of this product category; for some select countries, which market has created more value-added - domestic consumption or external demand; what has been the trend in the share of domestic value-added in total demand of this product category in some countries; and what was the contribution of this product category as input in India's exports of IT Services? Answers to these questions can provide useful guidance for developing countries that may be in the process of taking a decision on whether to join ITA/ITA-2, or not.

Section B of the paper discusses the methodology and data sources used in this study. Section C provides a substantive analysis of the performance of CEO products in different countries, mostly for the period after the implementation of the ITA and seeks to answer the questions mentioned in the preceding paragraph. Section D draws some broad concludes.

B. METHODOLOGY AND DATA SOURCES

It is relevant to provide an explanation of the framework of analysis based on value-addition, as adopted in this study. As production in IT hardware sector is characterised by fragmentation of the manufacturing process and prevalence of global value chains, by way of explanation it is useful to refer to the approach of Koopman et al. (2010)[7]. Under this approach, an international supply chain distributes value-added shares among countries in a particular industry. Within the supply chain, each producer purchases inputs and then adds value, which is included in the cost of the next stage of production. The Koopman framework distributes all value-added in a country's exports to its original sources. Under the approach, gross exports are split into domestic value-added that is exported, domestic value added initially exported but ultimately returns in home country's imports, and foreign value added embodied in gross exports. Measuring value-added embodied in exports requires the construction of a database detailing international production and use for all flows of value-added. To precisely define such chains across many countries, the database must quantify the contribution of each country to the total value-added generated in the process of supplying final products (Koopman et al., 2010). Using an approach similar to that of Koopman et al. (2010), OECD has constructed a detailed database called Trade in Value-Added (TiVA) Database. In our analysis we use two different editions of the TiVA database - TiVA 2015 edition and TiVA 2018 edition.

At the backbone of the TiVA Database are the harmonised Input-Output (I-O) tables for different countries, which are linked with bilateral trade data in order to estimate the share of domestic value-added both in exported and imported goods and services. It also tracks down foreign value-added to the original source country. The OECD TiVA methodology takes cognisance of the possibility that a part of the value of the imports from the last known exporting country may originate from third countries. Overall, the methodology underlying the TiVA Database requires a full set of inter-country I-O tables, where all bilateral exchanges of intermediate goods and services are accounted for[8]. The TiVA database also provides detailed estimates of final demand in the country for final goods and services of a

particular industry, broken down by the value added originating from different source industries in different source countries. This reveals how the value of final demand goods and services consumed within a country is an accumulation of value generated by many industries in many countries[9].

The 2015 edition of the TiVA database includes 62 economies covering OECD, EU28, G20, most East Asian and South-east Asian economies and a selection of South American countries. The industry list covers 34 unique industrial sectors, including 16 manufacturing and 14 services sectors. The years covered are 1995, 2000, 2005 and 2008 to 2011[10]. The 2018 edition of the TiVA database provides indicators for 64 economies including all OECD, EU28 and G20 countries, most East and South-east Asian economies and a selection of South American countries. Moreover, 36 unique industrial sectors[11] are represented within a hierarchy, including aggregates for total manufactures and total services. This edition covers the period 2005 to 2015, with preliminary projections to 2016 for some indicators.

In respect of the TiVA database, some caveats are in order. The database requires a vast array of data, which for many countries are limited or unavailable. Imputations, adjustments and strong assumptions are therefore required, which necessarily weaken the quality of the TiVA estimates and create discrepancies with the traditional gross trade data published by National Statistical Offices (Yamano and Webb, 2018)[12]. Further, the production assumption outlines that all "consumers of industries' outputs purchase exactly the same shares of products produced by all of the firms allocated to that industry and that all firms providing those inputs have, in turn, the same production functions and same intensity in the use of imports" (OECD, 2018)[13]. The quality of the TiVA estimates can also be affected by the 'proportionality' assumption, which states that "for a given product, one assumes that the proportion of intermediates that industry purchases from abroad are equal to the ratio of imports to total domestic demand in that product" (OECD, 2015)[14]. These assumptions result in making exporting firms more integrated into global supply chains and therefore having a higher import share of production/exports (OECD, WTO OMC, 2013)[15].

A further limitation is that the current dataset covers only 64 economies, which include all the OECD and EU countries individually, as well as most of the East and South-East Asian economies. Estimates for most developing economies are not available. The prospect of including more countries depends on the availability and quality of the underlying national statistics (Lee *et. al.* 2020)[16]. These limitations suggest that the indicators based on the TiVA data are best suited for obtaining aggregate-level outcomes or insights concerning GVCs.[17]

Table 2: TiVA Datasets and variables used in this study

Dataset	Variables
Trade in Value Added (TiVA): Principal indicators (Edition 2018)	Indicator EXGR_DVA: Domestic value-added content of gross exports
	Industry: Computer, electronic and optical products
	Partner country / region: World
Trade in Value Added (TiVA): Principal indicators (Edition 2018)	Indicator EXGR_FVA: Foreign value-added content of gross exports
	Industry: Computer, electronic and optical products
	Partner country / region: World
Trade in Value Added (TiVA) - Origin of value-added in final demand (Edition 2015 and Edition 18)	Value-added source industry: TOTAL
	Country of final demand: Choice depending on the country for which data is required
	Industry of final demand: Computer, Electronic and optical equipment
Trade in Value Added (TiVA) - Origin of value-added in gross exports (Edition 2015 and Edition 18)	Source industry: TOTAL
	Exporting Country: Choice depending on the country for which data is required
	Exporting industry: Computer, Electronic and optical equipment
Trade in Value Added (TiVA) - Origin of value-added in gross exports (Edition 2015)	Source industry: TOTAL
	Exporting Country: India
	Exporting industry: Computer and related activities
Trade in Value Added (TiVA) - Origin of value-added in gross exports (Edition 2015)	Source industry: Computer, Electronic and optical equipment
	Exporting Country: India
	Exporting industry: Computer and related activities

It is useful to provide specific illustrations of how some of the datasets in TiVA were used in this study. In respect of analysis involving the origin of value-added in final demand, we use the dataset "Trade in Value Added (TiVA) - Origin of value-added in final demand". This dataset has the

following three variables - “Value added source industry”; “Country of final demand”; and “Industry of final demand”. We set the first variable to “Total” which represents inputs from all source industries. We set the second variable according to the country for which the final domestic consumption is required. The third variable is set to Computer, Electronic and optical equipment. This provides details of the final demand of CEO products consumed in the country, along with the value-addition created in different countries on account of this demand. To illustrate, if we use the 2018 edition of TiVA then the dataset “Trade in Value Added (TiVA) - Origin of value added in final demand” for CEO products and set for India as the “Country of final demand”, then we can extract the following information: During the year 2005, the final demand of CEO products consumed in India was $ 8,756 mn. This demand created $ 3721.8 mn. value added in India (referred to as domestic value-added) and $ 5034.2 mn. in other countries (referred to as foreign value-added). Table 2 provides details of the TiVA datasets and the setting of the different variables in them which were used in this study.

Why are CEO products a good proxy for products covered under the ITA? This question is best answered by noting that TiVA has the following industries in manufacturing: Food products, beverages and tobacco; Textiles, wearing apparel, leather and related products; Wood and paper products; Basic metals and fabricated metal products; Chemicals and non-metallic mineral products; Computer, electronic and optical products; Electrical equipment; Machinery and equipment, nec; Transport equipment; Other manufacturing; repair and installation of machinery and equipment. From the categorisation of manufacturing industries in TiVA, it is clear that most of the products covered under the ITA, particularly IT hardware, would fall within the scope of computer, electronic and optical products. However, it is possible that a few of the ITA products might fall in other category of industries, such as Electrical equipment; and Machinery and equipment. But it is not unreasonable to assume that most of the ITA products would be within the category of CEO products.

A final and important caveat is in order. The data provided in OECD TiVA datasets are, at best, estimates. Thus, instead of focusing on the absolute

value of different variables, it may be more appropriate to concentrate attention on cross-country comparisons and trends over time.

C. ANALYSING TRENDS IN VALUE-ADDITION IN COMPUTERS, ELECTRONICS AND OPTICAL PRODUCTS

The electronics sector is characterised by the ability to codify system elements using computer-aided design (CAD) technologies. Digitisation allows codification and standardisation of components and other system elements. As a result, Multi-National Corporations (MNCs) (generally referred to as "lead firms" in the context of global value chains) are able to standardise the production of parts as much as possible. This enables the various economic activities, including product design, manufacture of parts and components and assembly of final products being separated and distributed among the different suppliers at geographically separate locations. Given these characteristics, component producers and other firms in the supply chain of electronics and computer hardware sector can be substituted without a need for substantial engineering changes to redesign the entire product[18,19].

These features of the computer and electronics industry mentioned above have consequences for our analysis. First, parts and components cross customs borders repeatedly in many countries, before the final product is assembled. Thus, if a country imports most of the parts and components, but undertakes relatively low amount of value-addition before exporting the product, then the value of gross exports would convey an incorrect picture of its capabilities and participation in international trade. A similar concern can be raised if the domestic output for meeting domestic demand is based on a high share of imported content (also referred to as foreign value-added). Second, with the cost of parts and components declining, availability of skilled manpower and labour costs have emerged as important determinants of the location of manufacturing parts and components, as well as the assembly of final parts. As a result, over the past three decades, lead firms based in developed countries have progressively increased off-shoring of the

manufacturing segment of computer and electronic products to many developing countries, such as China, Mexico, Malaysia, Singapore, Chinese Taipei, Thailand and now Vietnam. This was the predominant trend prior to the Covid-19 pandemic. Third, many studies (see, for example, Ali-Yrkkö et al., (2011)[20] and Sturgeon & Kawakami (2011)[21]) have shown that activities related to manufacturing generate the least per-unit value-added, as compared to activities preceding and succeeding the manufacturing segment in the product life cycle. Thus, despite the fact that most of the manufacturing of computer and electronic products is undertaken in developing countries, a larger proportion of value-added is created in countries where non-manufacturing economic activities related to the value chain are undertaken. These features are helpful in understanding what has happened to domestic producers of computer and electronic products in different countries.

In this section, we seek to answer some of the questions raised in this paper. While some anecdotal accounts are available as answers, we seek to provide quantitative estimates as responses to the questions regarding the performance of domestic CEO products industry in the wake of implementation of ITA. Analysis in this section would be highly relevant for some countries that might be contemplating joining the ITA/ ITA-2.

(i) Exports of Computers, Electronics and Optical Products: Comparing trends in Gross Exports and Value-added created by exports

As mentioned earlier, the manufacture of computer and electronic products involves domestic value-addition to foreign value-added embodied in imported inputs. If country A merely assembles imported parts and components, then the per unit domestic value-added would be relatively lower compared to country B, which uses more of domestically-sourced inputs as compared to imported inputs. Even if both countries have the same value of gross exports, the relative capabilities of the two countries would be quite different. Country B would have a much higher domestic value-added than country A. Thus, domestic value-added created by exports of CEO products, rather than the gross exports, would be a better

reflection of the economic capabilities of a country in this sector. Table 3 provides trends in shares of ten countries in gross exports of CEO products to the world, as well as their shares in value-added created by exports of all countries. To elaborate, in 2015, Japan's share in total gross exports of CEO products of all countries to the world was 4.2 percent. However, Japan's share rises to 5.4 percent, if we consider the domestic value-added created in all countries of the world on account of exports of CEO products.

Table 3: Comparison of share in gross exports of CEO products and share in domestic value-added created by exports of CEO products

Country/ Economy	Share in Gross Exports of CEO Products						Share in Domestic Value-Added created by exports of CEO Products					
	2005	2007	2009	2011	2013	2015	2005	2007	2009	2011	2013	2015
China	19.5	24.3	26.8	30.2	33.9	34.8	17.6	23.0	28.0	31.7	34.8	36.4
Germany	2.8	3.5	4.0	4.1	3.8	3.6	3.6	4.4	4.9	4.9	4.6	4.1
Japan	8.2	7.5	6.2	5.8	4.5	4.2	11.4	10.1	8.3	7.7	5.9	5.4
UK	2.1	1.6	1.3	1.2	1.0	1.0	2.4	1.7	1.5	1.3	1.2	1.2
USA	9.3	8.1	6.7	5.6	5.5	5.4	12.9	11.3	9.5	8.0	7.7	7.5
Brazil	0.4	0.3	0.2	0.1	0.1	0.1	0.5	0.4	0.3	0.2	0.1	0.1
India	0.1	0.2	0.4	0.4	0.3	0.2	0.1	0.2	0.3	0.4	0.3	0.2
Malaysia	6.2	5.7	5.1	4.6	4.0	3.9	3.3	3.2	3.0	2.8	2.6	2.6
Thailand	2.5	2.0	2.4	2.4	2.3	2.4	1.7	1.5	1.8	1.6	1.7	1.9
Viet Nam	0.1	0.2	0.3	0.5	0.6	0.8	0.1	0.2	0.2	0.4	0.4	0.5

Source: Calculations based on the following Datasets of Trade in Value Added (TiVA) 2018 Edition: (i) Principal indicator EXGR_DVA: Domestic value-added content of gross exports; and (ii) Indicator EXGR_FVA: Foreign value-added content of gross exports

For our purposes, three important conclusions emerge from the table. First, with the exception of China, the shares of other countries in both gross exports and value-added created by gross exports steadily declined during the ten year period of 2005-2015. This broad pattern confirms the trend in the production of computer and electronic products shifting to China and territories in its vicinity, which started in the early 1990s and gathered substantial momentum during 2005-2015.

Second, the five countries in the top band paint a distinctively different picture from the remaining five at the bottom. The shares of Germany, Japan, US, UK, and China in *domestic value-added* created by gross exports are higher than their corresponding shares in *gross exports*. On the other hand, the shares of Brazil, India, Malaysia, Thailand and Vietnam are higher in gross exports as compared to those in domestic value-added created by

gross exports. This trend is perhaps reflective of the underlying reality that the countries in the top band have created value-added domestically through providing high technology for production of CEO product, while countries at the bottom rely on assembling mainly imported parts and components for creating value-added for their economies. As far as China is concerned, it has started relying more on domestic inputs, as compared to foreign-sourced inputs.

Third, for some countries, such as Vietnam, gross exports provide an over-estimate of their capabilities in the production of CEO products. This becomes evident when we consider that in 2005 out of the $ 1bn. exports of CEO products by Vietnam, $ 532 mn. was contributed by domestic value-added. Over the decade, foreign content in gross exports increased faster than the domestic value-added. While the gross export of CEO products in 2015 was almost twelve times than that in 2005, domestic value-added increased eight times, during the same period. Thus, in order to compare the export performance and capabilities of countries in the CEO products sector, it is important to examine domestic value-added created by gross exports, rather than analysing gross exports.

(ii) Domestic market vs. Export market: What creates more domestic value-addition

In an assembly-oriented industry like IT goods, production essentially involves assembling a number of components and sub-assemblies based on a given design. This implies that the production in any country will require significant imports and a substantial proportion of the output gets exported to other countries rather than being sold in the domestic market. Thus, duty-free trade in CEO products is primarily in the interest of the exporting countries. These countries would prefer that other countries bind their tariffs on CEO products, including on parts and components, at zero. On the other hand, those countries which produce mainly for their domestic consumption may not be inclined towards committing to a legally binding duty-free regime. These countries can voluntarily reduce their tariffs on parts and components, without having the need to join ITA or ITA-2. By not being part of these agreements, they retain the policy option of protecting their producers of CEO products through tariffs. This policy flexibility would get completely curtailed if these countries were to join the ITA or ITA-2.

Thus, who sells where - in domestic or foreign markets - might help explain why some emerging economies have kept away from the ITA/ITA-2.

To test the hypothesis mentioned above, we first note that the total demand for CEO products in a country comprises two components - export demand and domestic consumption. We analyse the domestic value-added created by exports of CEO products and compare it with the total value-added created for meeting domestic consumption and export demand. Results are shown in Table 4.

Table 4: Domestic value-added created by exports of CEO products as a percentage of total domestic value-added created by domestic consumption and exports of CEO products

Country/ Economy	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
China	81.2	82.3	82.5	78.5	73.0	73.0	72.2	73.6	72.3	70.7	71.9
Germany	42.0	46.5	46.9	63.0	65.4	65.5	64.6	67.2	66.6	68.8	69.3
Japan	43.1	45.6	45.2	43.5	38.5	40.2	40.0	45.9	47.5	49.1	50.3
Korea	84.3	82.3	83.9	86.6	89.9	87.4	84.9	86.5	88.2	88.5	91.5
Singapore	94.8	96.7	92.2	90.3	87.8	88.7	91.7	87.2	88.6	91.6	91.4
Chinese Taipei	82.5	87.1	88.6	87.1	88.4	88.1	88.1	87.1	87.6	88.5	89.1
Thailand	92.1	91.5	92.7	90.4	94.7	91.0	89.8	89.5	88.9	91.6	94.6
UK	67.6	54.0	62.8	65.7	69.2	70.4	70.6	66.3	66.9	67.0	68.0
USA	28.6	28.7	27.2	31.0	29.6	28.8	29.5	30.0	34.8	33.2	38.6
Argentina	12.0	13.3	11.4	9.6	8.3	6.3	5.8	4.7	4.5	5.0	3.0
Brazil	22.4	19.0	13.3	11.9	10.3	8.9	6.2	6.1	5.5	4.9	7.2
India	19.3	20.8	20.2	24.8	27.1	26.7	27.8	21.9	26.1	21.9	22.3
Indonesia	59.3	48.5	42.0	39.1	41.7	35.7	31.7	30.7	26.9	26.6	25.2

Source: Calculations based on the following Datasets of Trade in Value Added (TiVA) 2018 Edition: (i) Principal indicator EXGR_DVA: Domestic value-added content of gross exports, and (ii) Origin of value-added in final demand

By way of elaboration, it may be noted that in 2015, in Singapore about 92 percent of the domestic value-added was created on account of exports of CEO products by the country, while less than 8 percent of domestic value-added was created due to domestic consumption of these products within Singapore. Thus, the information contained in Table 4 helps us understand the relative salience of export demand and domestic consumption in creating domestic value-added by the manufacture of CEO products in a country.

In most of countries/economies in the top band, a large share of the total domestic value-added created by CEO products originates on account of export demand rather than from domestic consumption of these products. It is, therefore, not surprising that most of these countries initially were at the forefront of pushing for the expansion of the ITA, and are now seeking new participants to the ITA-2. Superficially speaking, the US might appear to be an outlier, as less than 40 percent of the domestic value-added was created from exports. However, over the years there has been an increase of almost ten percentage points in value-added generated by exports of CEO products from the US, thereby bringing it close to 40 percent. Further, the total domestic value-added generated by these exports was $70 bn. in 2015. These two factors help explain the enduring interest of the US in seeking tariff elimination on CEO products by WTO Members.

In contrast to the countries/economies discussed above, in the countries in the bottom band of table 4, exports accounted for a small fraction of total domestic value-added created by exports and domestic consumption. In these countries, more than 75 percent of the domestic value-addition arose from domestic consumption of CEO products. Thus, the export market does not hold the same salience and attraction for these countries, as it does for the countries in the top band. It is therefore not surprising that these countries have remained lukewarm to the ITA and ITA-2. While India and Indonesia did join the ITA, none of the four countries in the bottom band are participants in the ITA-2.

(iii) Share of Domestic Value-Added in Total Demand for Computers, Electronics and Optical Products

As mentioned earlier, the total demand for CEO products in a country comprises two components - export demand and domestic consumption. Further, both these streams create value-added within the country, as well as in other countries. If a country is overwhelmingly dependent on imports of parts and components, as well as for the final CEO products, then domestic value-added will comprise a low share in its total demand. Thus, the trend in shares of domestic value-added in total demand (exports plus

domestic consumption) provides a useful basis for comparing the performance of domestic CEO industry across countries (Table 5).

By way of explaining Table 5, in respect of South Korea in 2015, out of the total value-added created by the total demand for CEO products (export demand plus domestic consumption) about 60 percent accrued domestically and about 40 percent of the value-added was created in other countries. In contrast, for the same year in Vietnam, about 30 percent of the total value-added was created domestically and 70 percent was created in other countries. This indicates a significantly higher reliance on foreign inputs for the manufacture of CEO products in Vietnam, as compared to South Korea.

Table 5: Total demand for CEO products and share of domestic value-added in total demand for CEO products

Country/ Economy	Total demand for CEO products (bn. USD)						Share (%) of domestic value-added in Total demand for CEO products					
	2005	2007	2009	2011	2013	2015	2005	2007	2009	2011	2013	2015
China	247	376	423	637	750	736	52.7	55.4	63.2	61.1	61.3	64.8
Germany	73	104	94	126	120	102	70.1	67.0	55.9	53.3	54.8	54.8
Japan	202	217	191	231	178	150	78.3	77.5	78.9	74.0	66.6	66.9
Korea	116	144	120	169	177	168	59.0	60.6	58.6	55.7	58.9	60.9
Singapore	38	40	41	63	64	58	58.3	60.5	61.2	52.7	56.2	55.6
Chinese Taipei	103	123	99	148	148	144	56.2	55.0	59.5	59.9	64.3	66.2
Thailand	30	30	31	44	47	42	37.1	39.7	41.6	36.6	40.0	43.9
USA	421	496	353	392	337	282	64.3	62.3	63.3	61.6	62.5	64.9
Argentina	4	5	6	9	11	10	31.4	31.9	38.9	36.6	40.0	45.2
Brazil	25	39	41	46	46	27	53.3	55.5	52.2	48.8	45.2	46.4
India	10	17	21	35	32	25	45.5	42.7	42.5	33.2	34.6	34.3
Indonesia	12	15	18	29	31	25	52.9	54.8	49.5	47.4	48.3	55.3
Vietnam	2	4	6	10	13	15	37.5	30.7	37.4	37.3	30.9	30.3

Source: Calculations based on the following Datasets of Trade in Value Added (TiVA) 2018 Edition: (i) Principal indicator EXGR_DVA: Domestic value-added content of gross exports; and (ii) Origin of value-added in final demand

The data in Table 5 lends itself to many conclusions, two of which stand out prominently for countries/economies in the top band. First, among the countries/economies included in the top band in the table, during 2005-2015, the share of domestic value-added in total demand for CEO products has increased by 10 percentage points, or more, for China and Chinese Taipei. Following two factors may be responsible for this trend: first, replacing some of the imported inputs with domestically manufactured parts and components; and second, the rise of lead firms in these countries in CEO products, resulting in incremental domestic value-addition from

activities other than manufacturing. Second, with the exception of China, Chinese Taipei and Thailand, the share of domestic value-added in total demand, has dipped, or remained almost constant, for other countries/ economies in the top band. However, all these countries/ economies benefit from a large amount of domestic value-added in absolute terms. To illustrate, while Germany has witnessed a steep decline in the share of domestic value-added in total demand, total demand for CEO products created $56 bn. of value-added domestically.

The picture of the countries in the bottom band is more interesting. In respect of the two countries which are not part of the ITA, Argentina and Brazil, the share of domestic value-added in total demand is substantially lower than that in most of the countries in the top band. Thus, despite not being part of the ITA, the share of foreign value-added in total demand for CEO products in these two countries remains higher than that in countries/economies in the top band. As far as the three countries which are part of the ITA but not of the ITA-2 are concerned, India and Vietnam have witnessed a sharp decline in the share of domestic value-added in total demand of CEO products. For India, the share of domestic value-added crashed from 45 percent in 2005 to 34 percent in 2015.

Further, in absolute terms, the amount of domestic value-added created in 2015 was $ 8.6 bn. for India and $ 4.6 bn for Vietnam. These amounts do not appear significant, as compared to the amount of domestic value-added created in countries in the top band. Given this experience, it is not surprising that these two countries have chosen to stay out of the ITA-2. As far as Indonesia is concerned, total demand for CEO products created domestic value-added of $14 bn. The reason for Indonesia not joining ITA-2 appears to be to accelerate the push for increased domestic value-addition, which has shown an upward trend from 2010 onwards.

India's domestic sector of CEO products merits a further examination. While the share of domestic value-added in total demand for CEO products dipped precipitously by 11 percentage points during 2005-2015, it would be instructive to understand what was the situation in an earlier period. Unfortunately, we do not have data on a strictly comparable basis for previous years. However, an earlier version of the TiVA database – Edition

2015- provides some data which is quite relevant and instructive. Table 6 provides details of total demand for CEO products and the domestic value-added as a percentage of total demand for the years for which data is available in Edition 2015 of TiVA.

Table 6: Share of domestic value-added created in India due to the total demand for CEO products (TiVA 2015 Edition)

Year (1)	Total demand ($ bn.) (2)	Domestic value-added as a % of total demand (3)
1995	7.54	70.27
2000	8.60	60.93
2005	17.36	43.65
2008	26.99	37.70
2009	29.17	39.51
2010	30.97	44.12
2011	34.41	45.19

Source: Data in columns 2-3 based on calculations using the following Datasets of Trade in Value Added (TiVA) 2015 Edition: (i) Origin of value-added in gross exports; and (ii) Origin of value-added in final demand.

Data in Table 6 confirms the anecdotal evidence available from industry sources in India which suggest that the domestic firms in CEO products lost substantial market share to imports after India started implementing its commitments under ITA. As shown in column 3 of Table 6, while 70 percent of the total demand for CEO products in India was met from domestic value-addition prior to the implementation of ITA, this quickly fell to 60 percent with a few years of commencement of the commitments.

By 2005, the year in which India eliminated tariffs on all products within the scope of ITA, domestic value-added as a share of total demand further declined to 44 percent. By 2008, this dipped to 38 percent, and thereafter showed a marginal recovery. Nevertheless, it remains a fact that after India started implementing ITA and till 2011, domestic value-added as a share in total demand for CEO products declined by almost 25 percentage points. While the calculation in Tables 5 and 6 are based on different editions of TiVA and hence cannot be strictly compared, both tables point to the following unmistakable conclusion: after India started implementing ITA commitments, in the face of increased import competition at zero duty injected by ITA, a large segment of the domestic industry substantially lost its market share.

(iv) Share of Computers, Electronics and Optical Products as inputs in IT Services exports of India

Some studies have sought to attribute the success of a few countries in information and communications technology (ICT) services to their participation in the ITA. Ezell (2012)[22] provides details of the impressive performance of ICT services in China, India, Malaysia and Philippines and asserts that "countries whose businesses and consumers have access to best-of-breed, cost-competitive ICT products are likely to be better positioned to provide more competitive ICT services". Was India's participation in the ITA an important factor in spurring its exports of Information Technology Services? Let us recall that under the TiVA framework, the export of a product/service is an accumulation of value generated by many source industries upstream in many countries. We, therefore, examine this question by analysing the value-added created upstream in CEO products by exports of IT Services.

We use Edition 2015 of TiVA to examine whether duty-free imports of IT hardware contributed to the impressive performance of India's IT Services exports. From the dataset it is possible to identify the amount of value-added created in different upstream source industries on account of exports of India's IT services. This enables us to pinpoint the contribution of CEO products in India's IT services exports. In 2015 Edition of TiVA, the exporting industry which comes closest to IT services is computer and related activities. Table 7 provides details of the upstream value-added created in CEO products on account of India's exports of services of Computer and related activities.

As is evident from Table 7, the share of CEO products as inputs for India's exports of Computer and related activities services declined sharply from around 5 percentage points to less than 1 percentage point during the transition period when India commenced tariff reduction on IT products under the ITA. After tariffs on all products within the scope of ITA was reduced to zero in 2005, the contribution of CEO products as upstream inputs in exports of Computer and related activities services gradually declined to less than half a percentage point in 2011. These trends do not

support the contention that participation in ITA was an important factor in the impressive performance of India's IT services exports.

It could be argued by some that the low share of CEO products as upstream inputs in exports of Computer and related activities services is on account of the surge in exports of these services in the post ITA phase. No doubt, this could be a mathematical possibility. In order to test this hypothesis, we redo the calculation for different years after 2005 by taking the contribution of CEO products for respective years, but dividing it by exports of Computer and related activities services in 2005 (and not by the actual exports in the respective years). Even under the revised calculations, the share of CEO products in exports of Computer and related activities services in 2000 was at least 4 times higher than the shares during 2008-2011. This should leave us in no doubt that India's participation in the ITA cannot be an important reason for the surge in India's IT services exports.

Table 7: Share of CEO products as upstream inputs for India's exports of computer and related activities services

Year (1)	India's Gross exports of Computer and related activities services ($ mn.) (2)	Contribution of CEO products from all countries as Source Industry for India's gross exports of computer and related activities services ($ mn.) (3)	Share of CEO products from all countries in India's gross exports of computer and related activities services (4)= (3)*100/(2)
1995	963	50	5.1
2000	2376	125	5.2
2005	9238	74	0.8
2008	18406	118	0.6
2009	15178	87	0.6
2010	21791	112	0.5
2011	26394	113	0.4

Source: Calculations based on the following Dataset of Trade in Value Added (TiVA) 2015 Edition: Origin of value-added in gross exports. Exporting industry: Computer and related activities. For column 2 Source industry is set to Total. For column 3 Source industry is set to CEO products

There could be two reasons for zero-duty imports of IT hardware under the ITA not appearing as an important factor for the booming IT Services exports of India. First, IT hardware would constitute a small fraction of the total cost of firms exporting IT Services. Further, the saving on account of customs duties not required to be paid by the exporter would comprise an even smaller proportion of the total cost of IT Services exporters. This would

almost render into insignificance any positive impact of zero-duty imports under the ITA on IT Services exports. Second, under different export promotion schemes in India's EXIM Policy 1997-2002, including Export Oriented Unit (EOU) Scheme, Export Processing Zone (EPZ) Scheme, Electronic Hardware Technology Park (EHTP) Scheme or Software Technology Park (STP) Scheme, exporters of services could import "all types of goods" duty-free.[23] This incentive, in turn, would have further diminished the salience of the ITA for India's IT services exporters. Even without India becoming part of the ITA, an exporter of IT Services in STP could have imported IT hardware duty-free. It is also relevant to mention that India's IT services exports recorded high growth even *prior* to India signing the ITA.[24] Overall, based on empirical evidence it appears difficult to accept the argument that India's exports of IT services surged due to the country's participation in the ITA.

D. CONCLUSIONS

Understanding the economic performance of IT hardware industry in some of the countries in the post-ITA phase is not an end in itself, but it provides important policy inputs for countries which are being persuaded by developed countries, and their IT manufacturers, to join the ITA and ITA-2. A number of important policy-related conclusions emerge from this paper. First, focusing on gross exports of CEO products can provide misleading information about the capabilities of countries and economies in this sector. To illustrate, although the share of the US in gross exports of CEO products was 5.4 percent, its share in total value-added created by exports of these products was 7 percent. Thus, gross exports under-estimate the capabilities and gains of the US in this sector. On the other hand, for certain countries, such as Brazil, India and Vietnam, the data on gross exports substantially over-estimates their capabilities and performance in exports of CEO products. These are also the countries that have not joined ITA-2.

Second, for most of the countries/territories, which are participants in ITA and ITA-2, the export market has contributed a substantially higher share to the domestic value-added, as compared to domestic consumption. For

some of these countries/territories, including China, Chinese Taipei, South Korea, Singapore, and Thailand, during 2005-2015, more than 70% of the total domestic value-addition arose from exports. In respect of the US, over the years, the export market for CEO products has become more salient. During 2005-2015 there was an increase of almost ten percentage points in domestic value-added generated by exports of CEO products, bringing it close to 40 percent. It is, therefore, not surprising that these countries want zero-duty access in other countries, and are at the forefront of seeking to persuade the latter to join the ITA-2. On the other hand, in respect of Argentina, Brazil, India and Indonesia, during 2005-2015 domestic value-added created by domestic consumption was more than three times than that created by exports. For these countries, the domestic market plays a more important role than the export market. This can explain the reluctance of these countries to join the ITA-2.

Third, against the standard narrative that countries can benefit by plugging into global value chains of IT hardware by importing parts and components and adding some value domestically, the success of some of the prominent players of CEO products appears to be substantially home-grown, and not predominantly driven by imported inputs. During 2005-2011, domestic value-added contributed around two-thirds of the total demand for CEO products in China, Japan, Korea, Chinese Taipei, and the US. Although these countries/ territories are participants in the ITA and ITA-2, their success in CEO products was driven less by foreign inputs and more by domestic value-addition.

On the other hand, in countries not participating in ITA-2, such as Argentina, Brazil, India, Indonesia and Vietnam, foreign value-added contributed around half of the total demand. This provides another reason why these five developing countries have not warmed up to the ITA-2. It is relevant to note that in India the domestic value-added declined sharply from 45 percent in 2005 to around 34 percent in 2015. If we consider information from another dataset, then it becomes clear that during the implementation of ITA and thereafter, the domestic producers of CEO products in India took a massive hit as the share of domestic value-added in

total demand of these products plunged from 70 percent in 1995 to around 45 percent in 2011.

Fourth, the study did not find support for the claim made by some experts that the success of India's IT Services exports was on account of zero-duty imports of IT hardware under the ITA.

Overall, developing countries who have stayed away from the ITA/ ITA-2 should not get swayed by the supposed benefits of participating in these agreements. Instead, while taking a decision on this important issue in the context of either FTA negotiations or the Joint Statement Initiative on Electronic Commerce among some WTO members, developing countries must critically scrutinise the evidence of gains from participating in them as adduced by the proponents of these agreements. Developing countries must also take into account the experience of the producers of computer, electronic and optical products in some countries which have suffered after implementing obligations under ITA. Finally, another element in the decision-making process should be the appreciation that success in this sector depends crucially on a number of factors, including the following: first, domestic availability of many parts and components; second, availability of indigenous technology; and third, capability for undertaking activities related to non-manufacturing segments in the entire life cycle of IT hardware. If none of these elements is present in a country, then participating in the ITA/ITA-2 is unlikely to create substantial economic value for it. Any binding commitments will erode the much-needed policy space and reduce the ability of the governments to generate additional revenues.[25]

An important caveat is in order. The data provided in OECD TiVA datasets are, at best, estimates. Thus, instead of focusing on the absolute value of different variables, it may be more appropriate to concentrate attention on cross-country comparisons and trends over time. Further, the quality of data in the TiVA database is weakened by various assumptions and adjustments made for filling the gaps in data which exist for many countries.

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