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Are Production Networks Passé in East Asia? Not Yet*

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Abstract: *Many people have a vague notion that the room for expanding international production networks is almost exhausted and that this is why international trade has slowed down since the recovery from the great trade collapse. This paper presents evidence against such belief in the East Asian context by classifying finely disaggregated international trade data into five categories based on the stages of the production process. Our thorough data examinations show that the slowdown in world trade and East Asian trade was attributed mainly to sluggish growth in trade of primary goods and processed raw materials. In contrast, East Asian trade in manufactured parts and components and the assembled end products within international production networks mostly seen in machinery industries, continued to expand steadily, underpinned by the intensive margin growth. We argue that East Asian production networks did not slow down and the potentiality of the production networks has not been exhausted yet.*

Keywords: slow trade, global value chains, machinery trade, extensive and intensive margins, difference-in-difference

JEL Classification: F14, F23

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1. Introduction: What was the 'Slow Trade'?

In the past 10 years, international trade experienced great turmoil. The Global Financial Crisis caused a massive 'trade collapse' in 2008–2009. World trade quickly bounced back, but then 'slow trade' occurred in which the growth rate of world trade became slower than the growth rate of world gross domestic product (GDP) in real terms or, in other words, the long-term trade elasticity of income went down. Although international trade regained its vigour in 2017–2018 (Nikkei Asian Review, 2018), slow trade seemed to generate some apprehension about the future of the world economy.

One concern is about international production networks or global value chains (GVCs). Many people vaguely believe that the room for expanding GVCs is almost exhausted and that this is why international trade slows down. The Economist (2016), for example, posited that the decelerating reduction in the cost of doing business across borders may be one of the reasons for slow trade. Earlier, Constantinescu, et al. (2014) had speculated that slow trade is at least partially caused by structural changes in the expansion or contraction of GVCs and concluded that 'China's international supply chains may have matured.'[1] Nakajima, et al. (2016) conducted an econometric study and concluded that 70% of slow trade is explained by structural factors including an expansion of in-house production in China and a deceleration in the expansion of GVCs. In the past 3 decades, the East Asian economy has grown with the mechanics of international production networks, and development strategies have emphasised the effective utilisation of GVCs. It is very important for us to assess whether the potentiality of GVCs is exhausted or not.

In this short paper, we claim that East Asian production networks in the machinery industry did not slow down even after 2011. Our methodology is simple. Rather than using macro trade data as most of the previous studies did, we classify the finely disaggregated international trade data into five categories based on the stages of the production process, as shown below, and assess the evolution of world trade. GVCs may mean any sort of international industrial linkages, including trade in primary products and in the first unbundling in Richard Baldwin's words (Baldwin, 2016). Here we would like

[1] Earlier, Hoekman (2016) compiled various views on slow trade held by a number of economists.

to look in particular at international trade in the second unbundling or international production networks based on task-wise or production stage-wise international division of labour. To do so, trade in manufactured parts and components, most of which occurs in machinery industries, is highlighted. We conclude that international production networks did not slow down at least in East Asia. Opportunities for further widening and deepening of international production networks are not entirely exhausted yet.

The paper's plan is as follows: the next section provides a data overview of the evolution of world and East Asian merchandise trade by product category. Section 3 examines the recent evolution of international trade by decomposing the trade growth into the extensive and intensive margins. To better understand the recent trade trends, section 4 conducts an econometric analysis, and this is followed by the conclusion.

2. Data Overview

Let us begin by describing how we construct a dataset to be used throughout the paper in section 2.1. Using the dataset, section 2.2. provides an overview of the evolution of world and East Asian merchandise trade by product category based on the stages of the production process.

2.1. Data description

We use bilateral import statistics based on the Standard International Trade Classification (SITC) from 2001 to the latest year of 2016 obtained from the United Nations (UN) Comtrade database. To deflate nominal trade values as reported in the UN Comtrade and obtain constant United States (US) dollar series, we use the US import price index that is obtained from the US Bureau of Labor Statistics (BLS) website. The US import price index is regarded as a good proxy for the deflator of the world price because the US is the largest importer in the world market and therefore the product composition of US imports would well represent the worldwide pattern (Athukorala and Kahn, 2016).[2]

[2] Ideally, we would employ deflators constructed at the product or sector level; however, such

During the period of our interest, 116 countries reported import statistics based on SITC Rev. 3 or a newer version. East Asia is defined as ASEAN+6 and Taiwan in this paper.[3] As for Taiwan, we treat data for 'Other Asia, not elsewhere specified (code 490)' as that for Taiwan.[4] Amongst the East Asian countries of our interest, trade statistics based on the SITC are not reported by Lao PDR and Myanmar in 2003–2009, Brunei Darusalam in 2005, or Singapore in 2003. We add these four East Asian countries to the above 116 countries despite the missing information for some years, and thereby we have 120 countries in total in our dataset as listed in Appendix A.

Most countries originally report trade statistics based on the Harmonized Commodity Description and Coding Systems (HS) nowadays, and the original HS data are converted to the SITC basis by the system in the UN Comtrade.[5] For some countries, trade statistics based on SITC Rev. 4 are available from 2007 onward since the SITC Rev. 4 data are converted only from the HS 2007 data (or newer versions). In the UN Comtrade database, the SITC Rev. 4 data are always accompanied by the converted data based on SITC Rev. 3, which we could utilise. However, the conversion table from SITC Rev. 4 to the older Rev. 3 is not publicly available, which appears to be because there are substantial and complicated differences between the versions. Indeed, SITC product codes at the most disaggregated level (i.e., so-called Leaf codes) are omitted to a non-negligible extent when the SITC Rev. 4 data are converted to the older Rev. 3.[6] Thus, we prefer using data based on the latest version of the SITC whenever available, unless we need to use the Leaf-level time-series data with a consistent product classification of a long-lasting though obsolete version.

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disaggregated deflators based on the SITC are not available for US imports and other countries.

[3] ASEAN+6 includes ten ASEAN member countries – China, Japan, Republic of Korea, Australia, New Zealand, and India. We include only mainland China as 'China' in line with the statistical territory of China's external trade statistics and exclude Hong Kong (and other SARs) from our dataset to avoid the data issues arising from Hong Kong's important role in re-exporting from China to the rest of the world (and in the opposite direction).

[4] In principle, trade data for territories belonging to Asia, but not specified by country, could end up in 'Other Asia, nes (code 490).' In practice, only Taiwan's trade is included under this code, except for several countries (such as Saudi Arabia which report all their exports to unknown countries). See the webpage of the UNSD:
https://unstats.un.org/unsd/tradekb/Knowledgebase/Taiwan-Province-of-China-Trade-data.

[5] The conversion tables from a newer (version of) product classification to an older one are available at the webpage of the UNSD:
https://unstats.un.org/unsd/trade/classifications/correspondence-tables.asp.

[6] The Leaf codes of the SITC means the most disaggregated codes at either 4- or 5-digit level.

To provide a data overview from 2001 to 2016 (in the next subsection), we combine the bilateral import statistics based on SITC Rev. 3 and those based on SITC Rev. 4. For each country, we choose data based on a newer version of the SITC in each year. To investigate the margins of trade focusing on recent years, 2011–2016 (in section 3), we construct another dataset based only on SITC Rev. 4 because we prefer using data based on the latest SITC version whenever available, as discussed above. In the dataset based only on SITC Rev. 4, 96 countries are included, as shown in Appendix A. In addition, to conduct a regression analysis by comparing trade trends in the recent period of 2011–2016 to the period before the great trade collapse, 2003–2008 (in section 4), we construct a dataset based on the older SITC Rev. 3, despite the inevitable data issues at the Leaf level as discussed above, because we need the Leaf-level time-series data with a consistent product classification from 2003 to 2016. The dataset based on SITC Rev. 3 includes all the 120 countries as in the combined dataset.

We then sort out each of the SITC Leaf-level bilateral trade datasets according to the production stage indicators that are originally employed in the RIETI Trade Industry Database (RIETI–TID).[7] The RIETI–TID's production stage indicators are available based both on SITC Rev. 3 and Rev. 4.[8] There exist 3,121 codes in total at the SITC Rev. 3 Leaf level, 3,117 of which are included in the RIETI–TID's list of production stage indicators and can be grouped into five (sub)categories based on the stages of the production process: Primary goods; Intermediate goods, which include Processed goods and Parts & components as subcategories; and Final goods, which include Capital goods and Consumption goods as subcategories.[9] Similarly, for SITC Rev. 4, there exist 2,970 Leaf-level codes, 2,966 of which are included in the RIETI–TID's list and can be grouped

[7] The RIETI–TID website (http://www.rieti-tid.com/) provides aggregated data for the export and import values of selected countries/regions and country groups that are organized by industry (13 sectors), product category (five production stages), and year (from 1980 to the latest year). We make use of the RIETI–TID's production stage indicators and apply them to the disaggregated bilateral trade data obtained from the UN Comtrade so as to enable us to conduct a data analysis at a finer level.

[8] The corresponding table between SITC product codes and the production stage indicators is publicly available on the RIETI–TID website.

[9] At the SITC (both Rev. 3 and Rev. 4) Leaf level, the following four codes are not included in the RIETI–TID's list of production stage indicators: Electric current (3510); Postal packages not classified according to kind (9110); Special transactions and commodities not classified according to kind (9310); Coin (other than gold coin), not being legal tender (9610).

into the five product categories. We focus on analysing bilateral trade for those SITC Leaf codes for which production stages can be identified.

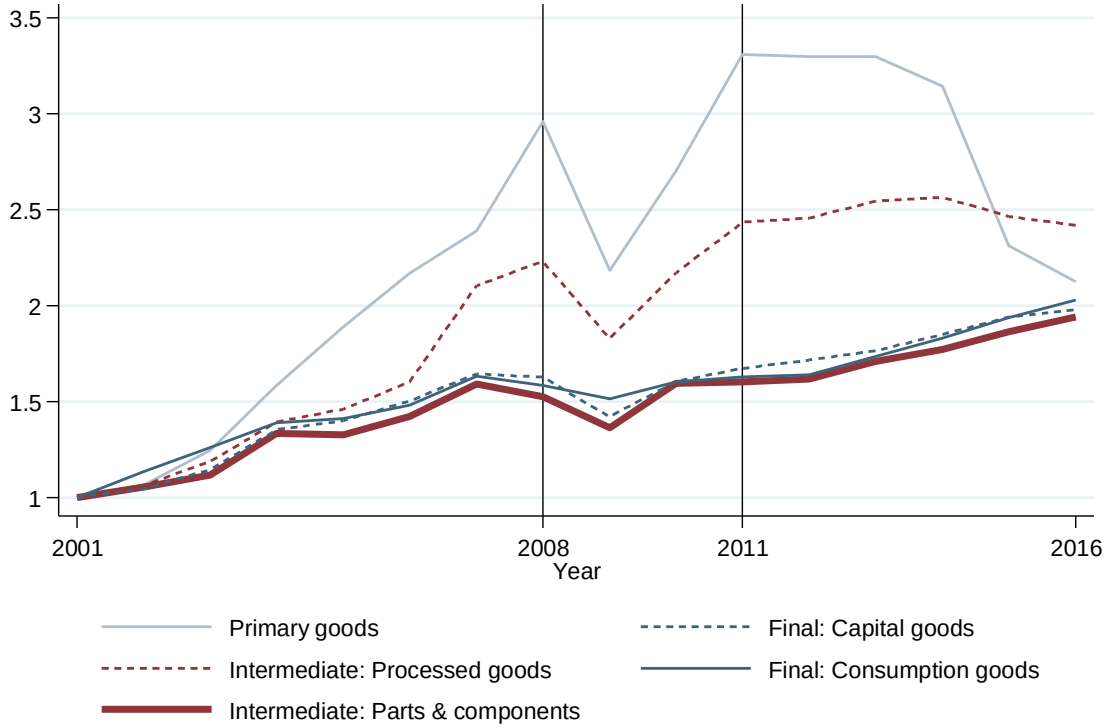
Making use of the RIETI–TID's production stage indicators enables us to investigate the evolution of international trade by five categories based on the stages of the production process. To check whether the potentiality of GVCs really has been exhausted or not, our interest is focused especially on trade in Parts & components amongst the five product categories. GVCs may mean any sort of international industrial linkages including trade in primary products and processed raw materials. However, we here would like to highlight the evidence suggesting that East Asian production networks in the machinery industry did not slow down even after 2011. In doing so, we look at trade occurring within international production networks based on cross-border unbundling of manufacturing production processes. Such network trade would encompass manufactured parts and components and the assembled end products, the former of which correspond to Parts & components while the latter are included only as part of the Capital goods and Consumption goods in the RIETI–TID. Here we would particularly like to look at trade in Parts & components as the network trade. Parts & components, as defined in the RIETI–TID, are mostly manufactured parts and components used in the machinery industries.[10]

2.2. Evolution of world and East Asian merchandise trade by product category

This subsection provides an overview of the trend of world merchandise trade using our dataset of bilateral trade flows decomposed into five product categories based on the stage in the production process as described in the previous subsection. Figure 1 shows an evolution of world merchandise trade from 2001 to 2016 by normalising the trade values in the initial year of 2001 to one for each product category. We add two vertical lines indicating the years 2008 and 2011 in the figure to help us compare the recent slowdown in world trade from 2011 onward with the trend before the great trade collapse in 2008–2009.

[10] From 1990 onward, more than 94% of world trade in the Parts & components occurs in machinery industries including General machinery, Electrical machinery, Household electric appliances, Transport equipment, and Precision machinery.

Figure 1: Evolution of World Trade, by Product Category, 2001–2016



Notes: See the text for our way of decomposing the world trade values into five product categories. The import values are deflated using the US import price index to obtain constant dollar series over the years of interest. The world total trade value for each product category in the initial year of 2001 is normalised to one.
Source: Authors' calculation using the SITC Rev. 3 and Rev. 4 Leaf-level bilateral import data (UN Comtrade) and the US import price index (the US BLS).

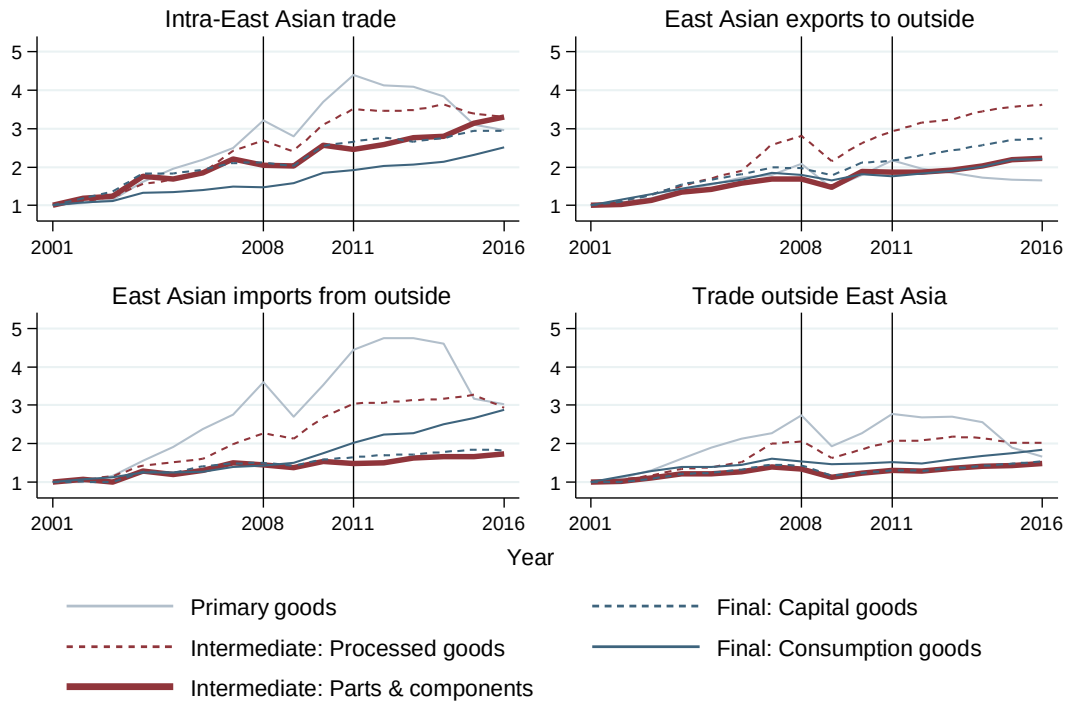
We can see in Figure 1 that the recent trade slowdown is attributed mainly to a drop in the trade values of Primary goods and to sluggishness in the trade of Processed goods. Note that most of the Processed goods in our dataset are chemical and mineral resource-related intermediate goods.[11] A certain portion of the decline in the trade values of primary goods and processed raw materials is accounted for by a substantial decline in resource prices from around 2014. In contrast, world trade in Parts & components, most of which are of machinery industries, continued to increase steadily even in recent years though growing at a relatively lower rate compared to the period before the great trade

[11] The Processed goods, as defined in the RIETI–TID, are mostly (semi-)processed raw materials used as intermediate goods for chemicals, iron and metal products, and petroleum and coal products. From 2007 onward, in particular, more than three-fourths of world trade in processed goods occurred in Chemicals, Iron and steel, Nonferrous metals, and Oil and coal industries. The corresponding proportion for machinery industries, for example, is limited to 4% or less.

collapse. A similar trend of steady growth is observed for world trade in final goods of both Capital goods and Consumption goods.

Figure 2 is a detailed version of Figure 1. We broke down world trade into four types of trade flows with a special interest in East Asian trade. The four types of trade flows are 1) intra-East Asian trade, 2) exports by East Asian countries to destination countries outside the region, 3) imports by East Asian countries from countries outside the region, and 4) trade between countries outside the region.

Figure 2: Evolution of Intra-East Asian Trade and Other Trade Flows, by Product Category, 2001–2016



Notes: See the notes of Figure 1. East Asia is defined as ASEAN+6 and Taiwan.
Source: Authors' calculation using the SITC Rev. 3 and Rev. 4 Leaf-level bilateral import data (UN Comtrade) and the US import price index (the US BLS).

First, we confirm from Figure 2 that the drop in the trade values of Primary goods in recent years is commonly observed irrespective of types of trade flows. The sluggishness in the recent trade of Processed goods is also a feature common to all the trade flows except East Asian exports to countries outside the region. Second, the continued steady growth in the trade values of Parts & components, Capital goods, and Consumption goods

is commonly observed in four trade flows. Nevertheless, it is noteworthy that East Asian imports of Consumption goods from countries outside the region, unlike other trade flows, did not decrease the pace of trade expansion in recent years compared to the period before the great trade collapse, but has achieved continued strong growth. More importantly, the continued steady increase of trade in Parts & components even in recent years is especially prominent in intra-East Asian trade.

Focusing on the recent years of the so-called slow-trade period, Table 1 reports trade values in 2011 and 2016 and the annual average percentage changes of trade values from 2011 to 2016 by product category and by trade flow type. First of all, the world total merchandise trade does stagnate with an annual average growth rate of 0.9% in the slow-trade period of 2011–2016, as pointed out in previous studies.

We also point out that contrasting patterns of recent trade growth are observed between 1) Primary goods and Processed goods and 2) Parts & components, Capital goods, and Consumption goods, as observed in Figures 1 and 2. The trade values of the first product group, except for East Asian exports of Processed goods to countries outside the region, decrease or remained almost unchanged during the period 2011–2016 as the name ‘slow trade’ suggests. In contrast, however, the trade values of the second product group expanded at annual average growth rates ranging from 1.8% to 7.3% for respective trade flows of each product category. In particular, intra-East Asian trade in Parts & components achieved an annual growth rate of 5.8%, which is the second highest rate following 7.3% for East Asian imports of Consumption goods from countries outside the region. And the third highest growth rate was 5.2%, which is observed for intra-East Asian trade in Consumption goods.

Summing up, we find two features of the trends of world and East Asian merchandise trade during the slow-trade period of 2011–2016. The first feature is that the trade slowdown is attributed mainly to the drop in trade values of primary goods and the sluggishness of trade in chemical and mineral resource-related processed raw materials. The other feature is that intra-East Asian trade in manufactured parts and components, most of which are of machinery industries, and in the final consumption goods, as well as East Asian imports of the final consumption goods from countries outside the region, achieved continued strong growth even in the slow-trade period. East Asian trade within international production networks appears not to have slowed down, coupled with the ever-increasing demand for the assembled end products from China and other East Asian developing countries.

Table 1: Trade Values, By Product Category and by Trade Flow Type, 2011–2016

	Total trade values (billion US $, constant)		
	2011	2016	Annual ave. % change
All product types, total	10,354	10,850	0.9%
Primary goods	1,430	917	-8.5%
Intra-East Asian trade	234	157	-7.7%
East Asian exports to outside	39	27	-6.7%
East Asian imports from outside	362	263	-6.2%
Trade outside East Asia	796	469	-10.0%
Intermediate: Processed goods	3,295	3,216	-0.5%
Intra-East Asian trade	658	610	-1.5%
East Asian exports to outside	356	418	3.3%
East Asian imports from outside	364	366	0.1%
Trade outside East Asia	1,918	1,821	-1.0%
Intermediate: Parts & components	1,730	2,057	3.5%
Intra-East Asian trade	432	573	5.8%
East Asian exports to outside	343	404	3.3%
East Asian imports from outside	168	196	3.0%
Trade outside East Asia	787	885	2.4%
Final: Capital goods	1,676	1,944	3.0%
Intra-East Asian trade	298	325	1.8%
East Asian exports to outside	461	569	4.3%
East Asian imports from outside	171	188	2.0%
Trade outside East Asia	746	862	2.9%
Final: Consumption goods	2,223	2,716	4.1%
Intra-East Asian trade	194	250	5.2%
East Asian exports to outside	515	624	3.9%
East Asian imports from outside	164	233	7.3%
Trade outside East Asia	1,350	1,609	3.6%

Notes: See the text for our way of decomposing the world trade values into five product categories. East Asia is defined as ASEAN+6 and Taiwan. The import values are deflated using the US import price index to obtain constant dollar series.

Source: Authors' calculation using the SITC Rev. 4 Leaf-level bilateral import data (UN Comtrade) and the US import price index (the US BLS).

3. Margins of Trade Growth in the Slow-trade Period

With the above-mentioned two features of the trends of world and East Asian merchandise trade during the slow-trade period of 2011–2016 in mind, in this section we investigate the margins of the total trade values. Specifically, we decompose the trade growth in the period 2011–2016 along the extensive and intensive margins, using a decomposition technique similar to Behrens et al. (2013) and Ariu (2016), by product category and by trade flow type. We would like to determine whether the noticeable features of the recent trends of world and East Asian trade occur at the extensive or intensive margin. In particular, if the continued strong growth of intra-East Asian trade in manufactured parts and components is attributed mainly to an increase at the intensive margin, we would interpret the findings as suggesting the upgrading of industrial base for input suppliers within East Asian production networks.

Let X_k denote the total trade values of a certain type of trade flows for a certain product category in a given year, i.e. k represents a particular type of trade flows at the product category level. X_k can be written as

$$X_k \equiv c_k \cdot \bar{d}_k \cdot \bar{p}_k \cdot \bar{x}_k,$$

where c_k is the number of origin (exporting) countries, $\bar{d}_k$ is the average number of destination (importing) countries per origin country, $\bar{p}_k$ is the average number of exported products per origin‑destination country pair, and $\bar{x}_k$ is the average value of exports per origin–destination–product triplet.

To decompose the changes in the trade values, we define $\Delta X_k \equiv X_k / X_k'$, where X_k' is the trade value in the earlier year and apply the same Δ transformation to all the terms on the right-hand side of the above equation. Then the total change in the trade values of X_k can be expressed as

$$\Delta X_k = \Delta c_k \cdot \Delta \bar{d}_k \cdot \Delta \bar{p}_k \cdot \Delta \bar{x}_k.$$

Changes in the first three terms on the right-hand side are referred to as changes in the extensive margins, while changes in the last term are referred to as changes in the intensive margin. By taking the logarithm of both sides of the equation, we can compute the relative contribution of each term of the extensive and intensive margins to the total change as follows:

$$1 = \underbrace{\frac{\ln \Delta c_k}{\ln \Delta X_k} + \frac{\ln \Delta \bar{d}_k}{\ln \Delta X_k} + \frac{\ln \Delta \bar{p}_k}{\ln \Delta X_k}}_{\text{The contributions of the extensive margins}} + \underbrace{\frac{\ln \Delta \bar{x}_k}{\ln \Delta X_k}}_{\text{The contribution of the intensive margin}} .$$

Table 2 reports the annual average percentage changes of trade values from 2011 to 2016 by product category and by trade flow type (the same as the rightmost column of Table 1), which are decomposed into the extensive and intensive margins as described above. Note that the number of origin countries, c_k, remains unchanged from 2011 to 2016 for all k as shown in the second left column, and we therefore do not compute the relative contribution to the total change in trade by this component of the extensive margin. Although East Asia is defined as ASEAN+6 and Taiwan, our dataset used for Table 2 includes all the East Asian countries of our interest except the Philippines (See Appendix A). Thus, the maximum possible number of origin countries in East Asian exports as well as intra-East Asian trade is 16. The dataset also includes 90 countries outside the East Asian region (again, as listed in Appendix A), and the maximum possible number of origin countries in East Asian imports and trade outside the region is 90.

As for the other three terms, Table 2 reports the average numbers of destination countries, $\bar{d}_k$, the average numbers of exported products, $\bar{p}_k$, and the average export values, $\bar{x}_k$, in 2011 and 2016, accompanied by their annual average percentage changes from 2011 to 2016 and the relative contributions to the total change in trade. The maximum possible number of destination countries in East Asia is 16 (or 15 in the case of intra-East Asian trade) while the corresponding number for destination countries outside the region is 90 (or 89 in the case of trade outside the region). The maximum possible number of Primary goods, Processed goods, Parts & components, Capital goods, and Consumption goods at the SITC (Rev. 4) Leaf level is 250; 1,307; 260; 458; and 691, respectively.

First, by comparing the relative contributions expressed in percentages by each margin (see the numbers shown in brackets), we find that the drop in trade values of primary goods and the sluggishness of trade in processed raw materials are mainly driven by a decrease in the average export value at the intensive margin. Note that the relative contribution takes a positive value when a decrease in the average export value contributes to the fall in the total trade values at the intensive margin (see, for example, the numbers shown in the first row for intra-East Asian trade in Primary goods).

Table 2: Changes in Trade Values at the Extensive and Intensive Margins, by Product Category and by Trade Flow Type, 2011–2016

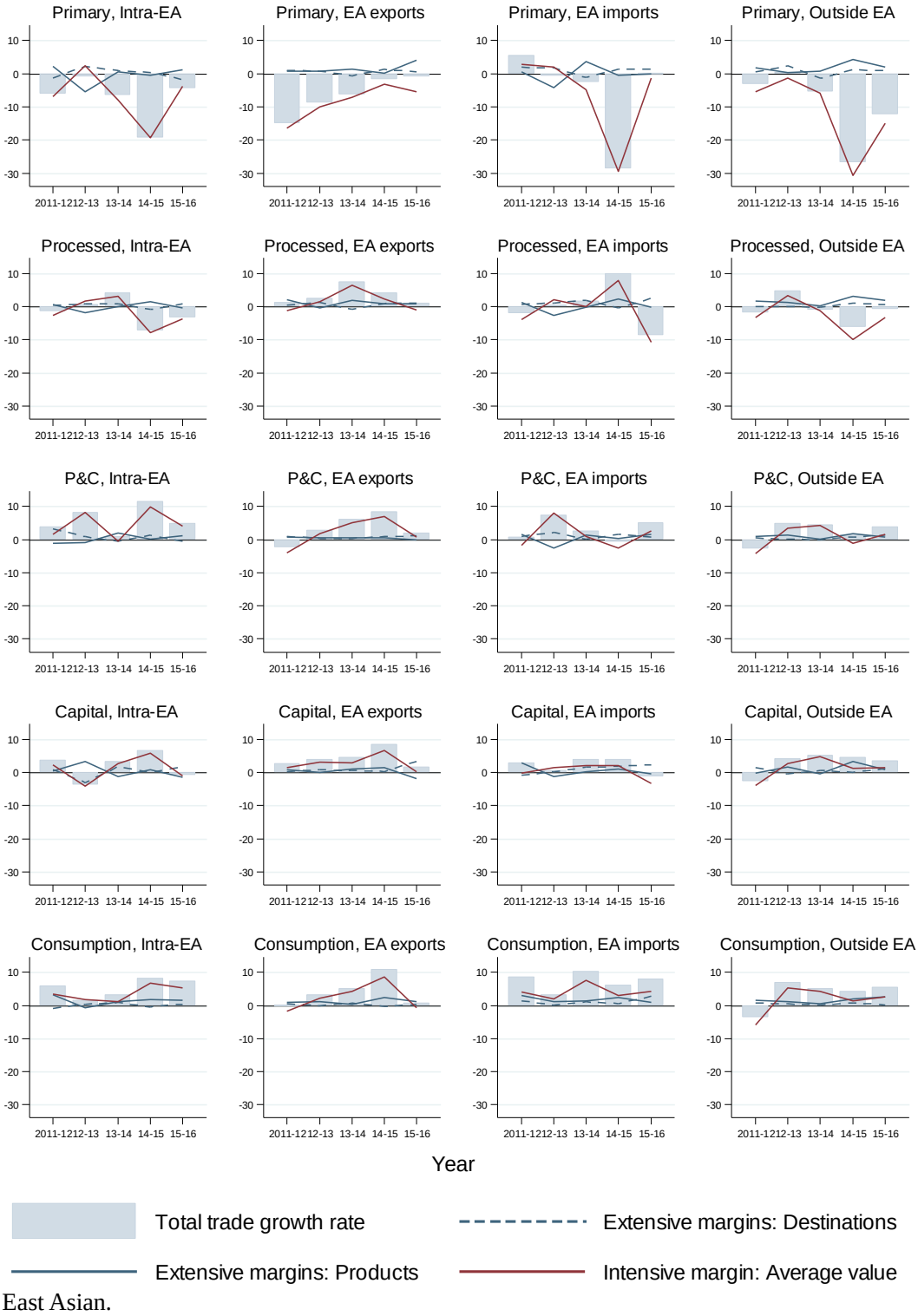
		Extensive margin **:**							***Intensive margin*** **:**		
		N. of origin countries	Ave. N. of destination countries			Ave. N. of exported products per origin-destination country pair			Ave. export value per origin-destination-product triplet (million US $, constant)		
	Annual ave. % change in total trade values	2011-16	2011	2016	Annual ave. % change [Contribution]	2011	2016	Annual ave. % change [Contribution]	2011	2016	Annual ave. % change [Contribution]
Primary goods											
Intra-EA trade	-7.7%	16	14.1	14.1	0.1% [-1.1%]	54.7	53.6	-0.4% [5.0%]	19.03	12.96	-7.4% [96.1%]
EA exports to outside	-6.7%	16	65.5	67.6	0.6% [-9.0%]	19.3	20.7	1.4% [-20.5%]	1.91	1.22	-8.6% [129.4%]
EA imports from outside	-6.2%	90	10.9	11.5	1.1% [-16.5%]	16.7	16.6	-0.2% [2.6%]	21.95	15.28	-7.0% [113.9%]
Trade outside EA	-10.0%	90	54.9	57.0	0.7% [-7.0%]	19.7	21.6	1.9% [-17.7%]	8.17	4.23	-12.3% [124.7%]
Intermediate: Processed goods											
Intra-EA trade	-1.5%	16	14.4	14.8	0.4% [-28.7%]	482.8	483.0	0.0% [-0.6%]	5.90	5.35	-1.9% [129.3%]
EA exports to outside	3.3%	16	76.3	78.6	0.6% [18.3%]	219.3	231.7	1.1% [33.9%]	1.33	1.44	1.6% [47.7%]
EA imports from outside	0.1%	90	12.6	13.4	1.2% [945.8%]	146.4	147.0	0.1% [65.6%]	2.18	2.07	-1.1% [-911.3%]
Trade outside EA	-1.0%	90	68.6	69.8	0.3% [-32.5%]	160.9	174.7	1.7% [-158.6%]	1.93	1.66	-3.0% [291.1%]
Intermediate: Parts & components											
Intra-EA trade	5.8%	16	13.8	14.4	0.9% [15.7%]	139.5	141.2	0.2% [4.3%]	14.01	17.56	4.6% [80.0%]
EA exports to outside	3.3%	16	73.4	76.3	0.8% [23.5%]	96.3	98.8	0.5% [15.6%]	3.03	3.35	2.0% [60.9%]
EA imports from outside	3.0%	90	11.7	12.4	1.1% [38.1%]	64.3	65.8	0.5% [15.1%]	2.48	2.66	1.4% [46.8%]
Trade outside EA	2.4%	90	63.6	65.4	0.5% [23.2%]	64.9	68.5	1.1% [45.8%]	2.12	2.20	0.7% [31.0%]
Final: Capital goods											
Intra-EA trade	1.8%	16	14.5	14.7	0.3% [14.7%]	188.2	192.2	0.4% [23.8%]	6.82	7.20	1.1% [61.5%]
EA exports to outside	4.3%	16	73.6	77.6	1.1% [25.6%]	115.4	117.0	0.3% [6.7%]	3.40	3.92	2.9% [67.8%]
EA imports from outside	2.0%	89	11.9	12.5	1.1% [53.6%]	71.5	73.3	0.5% [25.1%]	2.26	2.31	0.4% [21.2%]
Trade outside EA	2.9%	90	63.4	65.3	0.6% [20.6%]	79.3	83.7	1.1% [37.1%]	1.65	1.75	1.2% [42.3%]
Final: Consumption goods											
Intra-EA trade	5.2%	16	14.8	14.8	0.1% [1.7%]	279.3	299.1	1.4% [26.9%]	2.94	3.53	3.7% [71.5%]
EA exports to outside	3.9%	16	81.9	82.9	0.2% [6.3%]	162.6	172.2	1.2% [30.1%]	2.42	2.73	2.5% [63.6%]
EA imports from outside	7.3%	90	12.8	13.6	1.2% [16.8%]	94.4	103.0	1.7% [24.7%]	1.51	1.85	4.2% [58.5%]
Trade outside EA	3.6%	90	72.5	74.2	0.5% [13.4%]	116.0	125.3	1.6% [44.1%]	1.78	1.92	1.5% [42.5%]

EA = East Asian.

Notes: See the notes of Table 1. See the text for the method of decomposing the total change in trade into the extensive and intensive margins and calculating the relative contributions by each component of margins.

Source: Authors' calculation using the SITC Rev. 4 Leaf-level bilateral import data (UN Comtrade) and the US import price index (the US BLS).

Figure 3: Decomposing Yearly Trade Growth into the Extensive and Intensive Margins, by Product Category and by Trade Flow Type, 2011–2016



EA = East Asian.

Notes: See the notes of Table 2.

Source: Authors' calculation using the SITC Rev. 4 Leaf-level bilateral import data (UN Comtrade) and the US import price index (the US BLS).

Second, although increases in the average number of destination countries and in the average number of exported products at the extensive margin are non-negligible for the trade growth in Parts & components, Capital goods, and Consumption goods, we find that increases at the extensive margins tend to be dwarfed by an increase in the average export value at the intensive margin for those product categories. Such tendency is particularly true for intra-East Asian trade and East Asian exports. Indeed, the intensive margin contributes to 80% of the observed strong growth in intra-East Asian trade values of Parts & components despite the overall trade slowdown. As pointed out in section 2, the continued strong growth even in the slow-trade period is also observed for intra-East Asian trade in Consumption goods and for East Asian imports of Consumption goods from countries outside. All of this strong trade growth appears to be underpinned by an increase in the average export value at the intensive margin.

Figure 3 complements Table 2 by decomposing yearly trade growth during the slow-trade period of 2011–2016 along the extensive and intensive margins by product category and by trade flow type. More specifically, when defining $\Delta X_k \equiv X_k / X_k{}'$ and applying the same Δ transformation to all the margins, we here conduct a year-on-year comparison. The bar charts in each panel of Figure 3 indicate the yearly growth rates of the total trade values in percentages from 2011 to 2016, which are decomposed into the extensive and intensive margins on a yearly basis. A red line represents the yearly changes in the average export value at the intensive margin in percentage terms. Similarly, a solid and dashed blue line represents the yearly changes in the average number of exported products and the average number of destination countries at the extensive margin, respectively.

Figure 3 tells us at a glance that most of the ups and downs of the total trade values are closely tied to the changes in the average export value at the intensive margin for each type of trade flow in each product category, in line with what we found from Table 2. We would interpret these findings together as suggesting that the intensive margin is the key to understanding the observed features of the recent trends of world and East Asian trade, specifically, the sluggish growth in trade of primary goods and processed raw materials and the continued steady growth in trade of manufactured parts and components and the final goods. In particular, the intensive margin has greatly contributed to the strong growth of East Asian trade within international production networks, which would suggest that

the industrial base for input suppliers has improved in East Asian countries along with the progress of the production networks.

4. Regression Analysis

Next, we turn to an econometric analysis to understand what is going on behind the recent trends of world and East Asian merchandise trade. Of particular interest to us is the continued strong growth in intra-East Asian trade values of manufactured parts and components, as well as intra-East Asian trade and East Asian imports of final consumption goods, even after 2011. Given our findings that the intensive margin is the key to understanding the steady growth in trade of manufactured parts and components and final goods as well as the sluggish growth in trade of primary goods and processed raw materials in the previous sections, we here focus on changes in the trade values of the continuing origin–destination–product triplets (i.e. changes at the intensive margin). We examine whether and how the recent trends of the world and East Asian merchandise trade are different from the period before the great trade collapse – especially regarding East Asian trade in manufactured parts and components – by employing a difference-in-difference approach similar to Behrens et al. (2011) and Ariu (2016).

Before turning to the difference-in-difference approach, we present Table 3 to confirm the fact that the intensive margin plays an important role in explaining the recent changes of trade values not only at an aggregate level but at the origin–destination country pair level. Table 3 reports the estimation results for the ordinary least squares (OLS) decomposition of the growth in bilateral trade values from 2011 to 2016 into the extensive and intensive margins, following Bernard et al. (2009), by product category and by trade flow type. The estimated coefficient for each margin indicates the mean contribution across origin–destination country pairs to the total growth of a given type of trade flow in a given product category. We find from the table that about 80% or more of the changes in bilateral trade values occur at the intensive margin, which motivates us to take the difference-in-difference approach focusing on the intensive margin of bilateral trade growth as described below.

Table 3: OLS Decomposition at the Origin–Destination Country Pair Level, by Product Category and by Trade Flow Type, 2011–2016

	Extensive margin **:** N. of exported products		***Intensive margin*** **:** Ave. export value per product		***Obs*** **:** N. of origin-destination country pairs
	Coef.	Std. Err.	Coef.	Std. Err.	
Primary goods					
Intra-EA trade	0.058	[0.020]	0.942	[0.020]	220
EA exports to outside	0.101	[0.009]	0.899	[0.009]	978
EA imports from outside	0.102	[0.008]	0.898	[0.008]	929
Trade outside EA	0.086	[0.004]	0.914	[0.004]	4,491
Intermediate: Processed goods					
Intra-EA trade	0.178	[0.024]	0.822	[0.024]	230
EA exports to outside	0.187	[0.010]	0.813	[0.010]	1,184
EA imports from outside	0.117	[0.009]	0.883	[0.009]	1,103
Trade outside EA	0.118	[0.004]	0.882	[0.004]	5,783
Intermediate: Parts & components					
Intra-EA trade	0.180	[0.018]	0.820	[0.018]	219
EA exports to outside	0.208	[0.010]	0.792	[0.010]	1,130
EA imports from outside	0.179	[0.010]	0.821	[0.010]	994
Trade outside EA	0.168	[0.004]	0.832	[0.004]	5,307
Final: Capital goods					
Intra-EA trade	0.196	[0.018]	0.804	[0.018]	231
EA exports to outside	0.168	[0.009]	0.832	[0.009]	1,140
EA imports from outside	0.196	[0.009]	0.804	[0.009]	996
Trade outside EA	0.172	[0.004]	0.828	[0.004]	5,305
Final: Consumption goods					
Intra-EA trade	0.174	[0.025]	0.826	[0.025]	233
EA exports to outside	0.246	[0.011]	0.754	[0.011]	1,282
EA imports from outside	0.153	[0.010]	0.847	[0.010]	1,117
Trade outside EA	0.169	[0.005]	0.831	[0.005]	6,210

EA = East Asian.

Notes: See the notes of Table 1. See the text for the OLS decomposition of the total change in trade into the extensive and intensive margins. The estimated coefficient indicates the mean contribution to the total growth of each type of trade flow in each product category.

Source: Authors' calculation using the SITC Rev. 4 Leaf-level bilateral import data (UN Comtrade) and the US import price index (the US BLS).

Employing a difference-in-difference approach similar to Behrens et al. (2011) and Ariu (2016), we estimate the following equation using OLS for four types of trade flows with a special interest in East Asian trade:

$$\Delta x_{cdp}^{t} = \alpha + \beta_0{}' T^t + \beta_1{}' \boldsymbol{W}_{cdp}^{t} + \beta_2{}' \boldsymbol{W}_{cdp}^{t} \times T^t + \varepsilon_{cdp}^{t}.$$

The dependent variable is the change in (log) values of exports by origin country c to destination country d for product p at the SITC Leaf level,

$$\Delta x_{cdp}^{t} \equiv \ln\left(\frac{x_{cdp}^{t+5}+x_{cdp}^{t+4}+x_{cdp}^{t+3}}{3}\right) - \ln\left(\frac{x_{cdp}^{t+2}+x_{cdp}^{t+1}+x_{cdp}^{t}}{3}\right),\ t = 2003, 2011,$$

where we take a 3-year average of trade values for the base and ending year, respectively, in the same spirit of Kehoe and Ruhl (2013). T^t takes a value of one if $t = 2011$, indicating the slow-trade period of 2011–2016. $\boldsymbol{W}_{cdp}^{t}$ is a vector of origin country, destination country, and product characteristics, for which we include the percentage growth of GDP in destination country d to gauge the effects of the changing demand conditions. Data on GDPs (in constant US dollars) come from the World Bank's World Development Indicators (WDI) database. We also include product dummies for the categories of Primary goods, Processed goods, Parts & components, and Capital goods, by taking Consumption goods as the reference product category. In addition, we include origin country–industry fixed effects, which are the interactions of origin country dummies with the SITC one-digit industry dummies. ε_{cdp}^{t} is a residual term with the standard properties for the consistency of the OLS estimation.

The coefficients β_1 measure the impact of our covariates in the period before the great trade collapse in 2003–2008, which is regarded as the baseline period. The coefficients β_2 are for interactions of the covariates with the time dummy indicating the slow-trade period of 2011–2016 and capture the differential changes occurring in the slow-trade period compared to the baseline period. We are interested in the β_2 coefficients and the sum of β_1 and β_2, the latter of which corresponds to the gross impact of covariates in the slow-trade period.

Table 4: Regression on Continuing Origin–Destination–Product Triplets: The Slow-trade Period (DD) Compared to the Period Before the Great Trade Collapse (Base)

Type of trade flow:	Intra-East Asian trade		East Asian exports to outside		East Asian imports from outside		Trade outside East Asia	
Variables:	Base	DD	Base	DD	Base	DD	Base	DD
GDP growth in destination	0.00719	0.00509	0.0175***	0.0129***	0.0126***	-0.000867	0.0135***	0.00672***
	[0.00533]	[0.00637]	[0.00489]	[0.00303]	[0.00367]	[0.00583]	[0.00340]	[0.00228]
Primary goods dummy	0.0715	-0.216**	-0.0477	0.0895	0.0625	-0.129	0.0656**	-0.162***
	[0.0426]	[0.0809]	[0.0418]	[0.0689]	[0.0436]	[0.100]	[0.0280]	[0.0405]
Processed goods dummy	0.0768**	-0.217***	0.139***	-0.0990***	-0.0163	-0.0668*	-0.0103	-0.0626**
	[0.0304]	[0.0347]	[0.0253]	[0.0306]	[0.0355]	[0.0315]	[0.0195]	[0.0239]
Parts & components dummy	0.178***	-0.256***	0.241***	-0.132***	0.0675*	-0.0953*	0.0635***	-0.0927***
	[0.0343]	[0.0365]	[0.0311]	[0.0342]	[0.0371]	[0.0511]	[0.0205]	[0.0249]
Capital goods dummy	0.141***	-0.211***	0.189***	-0.109***	0.00926	-0.0479	0.0475**	-0.0646***
	[0.0370]	[0.0411]	[0.0299]	[0.0331]	[0.0565]	[0.0488]	[0.0195]	[0.0242]
Origin country-industry FE	YES		YES		YES		YES	
Observations	217,236		573,824		279,404		2,191,312	
R-squared	0.05		0.076		0.035		0.023	

FE = fixed effect.

Notes: See the notes of Table 1. See the text for the equation estimated by OLS. The 'Base' column refers to coefficients estimated for the listed destination and product characteristics alone while the 'DD' column refers to coefficients for interactions of these characteristics with the slow-trade time dummy. Coefficients are significant at *** p<0.01, ** p<0.05, and * p<0.1. Standard errors are clustered by the SITC Leaf-level code and by destination country and are reported in brackets.

Source: Authors' calculation using the SITC Rev. 3 Leaf-level bilateral import data (UN Comtrade) and the US import price index (the US BLS).

Table 4 reports the estimated coefficients for GDP growth in destination country and product dummies for the four product categories obtained through OLS from the above equation. Robust standard errors clustered by the SITC Leaf-level code and by destination country are reported in brackets. We run regressions separately for intra-East Asian trade, East Asian exports to countries outside the region, East Asian imports from countries outside the region, and trade between countries outside the region. The Base column refers to coefficients estimated for the listed variables (in the leftmost column) alone (i.e. β_1) while the DD column, which stands for difference-in-difference, refers to coefficients for interactions of the variables with the time dummy indicating the slow-trade period (i.e. β_2).

A few results behind the recent trends of world and East Asian trade stand out: first, the estimated coefficients for GDP growth in destination country are statistically insignificant for intra-East Asian trade both in the Base and the DD columns. In contrast, at baseline, a 1% increase in the aggregate demand of destination country leads to a 1.75% and 1.35% increase on average in East Asian exports to countries outside the region and in trade between countries outside the region, respectively. The differential change from the baseline to the slow-trade period captured by the coefficient reported in the DD column is also estimated to be significantly positive. The elasticity of East Asian export values to GDP of the destination country increases significantly to 3.04 in the slow-trade period, while the corresponding elasticity for outside-East Asian trade values goes up to 2.02. The estimates can be interpreted as indicating that the demand shock or recession in destination country would disproportionately decrease the trade values in these trade flows. In other words, intra-East Asian trade, unlike other types of trade flows, appears to be invulnerable to the changing demand conditions of destination country.

Second, the Base coefficients for product dummy indicating the Parts & components are estimated to be significantly positive and relatively large in magnitude compared to other product dummies for all East Asian trade flows but not for trade between countries outside the region. Our reference product category is Consumption goods. For example, intra-East Asian trade values of Parts & components achieve an on average 17.8% higher rate of increase compared to intra-East Asian trade of Consumption goods, suggesting a striking growth of trade in manufactured parts and components within the region during 2003–2008. The corresponding figure for the relative growth rate of Parts & components

trade is 24.1% for East Asian exports to countries outside the region and 6.75% for East Asian imports from countries outside the region. Unlike East Asian trade flows, the relative growth rate of Parts & components trade outside the region is limited to 6.35%, which is exceeded by the corresponding rate for Primary goods. These results are consistent with the well-recognised fact that East Asian production networks especially in the machinery industry have expanded remarkably in the first half of the 2000s. East Asian countries appear to have markedly increased exports of manufactured parts and components, mostly in machinery industries, to neighbouring trading partners within the region and even more so to countries in other parts of the world.

Third, the DD coefficients for the Parts & components dummy are estimated to be significantly negative for every type of trade flows, indicating a larger decline in the growth rate of trade in manufactured parts and components relative to final consumption goods from the baseline period of 2003–2008 to the slow-trade period of 2011–2016. Similar results are found for other product categories and otherwise the estimated coefficients are insignificant. These estimated results mean that the growth rates of trade in manufactured parts and components as well as the other product categories have slowed in a relative sense, compared to the changes in the growth rate of trade in final consumption goods from the baseline to the slow-trade period for each trade flow.

For intra-East Asian trade in Parts & components, the differential change from the baseline to the slow-trade period is estimated to be –25.6%, which means that the intra-East Asian trade values of Parts & components decrease by on average 7.8% (gross) relative to the reference product category of Consumption goods in the slow-trade period (0.178 – 0.256 = –0.078). In other words, intra-East Asian trade values of the final consumption goods on average grow at a rate higher than manufactured parts and components and all the other product categories in the slow-trade period, suggesting the development of intra-regional markets as an ultimate source of demand for assembled end products within international production networks in recent years.

Recall that at an aggregate level intra-East Asian trade values have largely increased since 2011 (as shown in section 2) – not only manufactured parts and components (at an annual average growth rate of 5.8%), but also final consumption goods (at the corresponding rate of 5.2%). Combining the aggregate-level facts with the high coefficient for the Parts & components dummy in the Base column, we can safely

interpret the estimates as suggesting that intra-East Asian trade of manufactured parts and components continued to increase steadily after 2011 but at a lower rate of growth compared to the period of the remarkable expansion of East Asian production networks while intra-East Asian trade of the assembled end products within the production, networks has expanded rapidly at an unprecedented rate of growth since 2011.

More interestingly, for East Asian exports to countries outside the region, although the estimated differential changes are significantly negative, the gross rate of growth in export values during the slow-trade period is positive for Processed goods, Parts & components, and Capital goods. In particular, East Asian export values of Parts & components increase by 10.9% faster than the reference product category of the Consumption goods in the slow-trade period. East Asian countries now appear to be exporting relatively more manufactured parts and components to destination countries outside the region, which can be interpreted as a sign of the upgrading of the industrial base for input suppliers within the production networks that are extending beyond East Asia.

5. Conclusion

In this paper we have thoroughly examined the evolution of international trade by classifying the finely disaggregated bilateral trade data into five categories based on the stages of the production process. We found that the slowdown in world and East Asian merchandise trade after 2011 is attributed mainly to a drop in trade values of primary goods and the sluggishness of trade in chemical and mineral resource-related processed raw materials. In contrast, intra-East Asian trade in manufactured parts and components, most of which occurs in machinery industries, and in final consumption goods, as well as East Asian imports of final consumption goods from countries outside the region, achieved continued strong growth even after 2011. Despite the trend of an overall slowdown, the expansion of East Asian trade within international production networks appears not to have decelerated.

We looked into the margins of trade and found that the continued strong growth in East Asian trade within international production networks was underpinned by increases in the average values of exports at the intensive margin. It appears that the industrial base for manufactured input suppliers within the production networks has improved in East Asian countries, leading to a strengthening of intra-regional trade ties.

We then conducted an econometric analysis focusing on the intensive margin of trade growth to compare the recent trends of world and East Asian trade with the trends during the period before the great trade collapse. Our results suggest that intra-East Asian trade of manufactured parts and components continued to increase steadily after 2011 though at a relatively lower rate of growth compared to the period in the remarkable expansion of East Asian production networks. But we also detected evidence to suggest that intra-regional markets as an ultimate source of demand for assembled end products within the production networks have rapidly developed since 2011. In addition, we obtained estimates indicating that East Asian countries have substantially expanded exports of manufactured parts and components not only to neighbouring trading partners, but also to countries in other parts of the world.

Many people have a vague notion that the room for expanding GVCs is almost exhausted and that this is why international trade has slowed since the recovery from the great trade collapse. We provided evidence to the contrary from East Asia. Our findings suggest that the expansion of trade within international production networks mostly seen in the machinery industry at least in East Asia has not slowed. Moreover, the spread of East Asian production networks to other parts of the world, coupled with industrial upgrading within the production networks, would suggest that the potentiality of the production networks has not been exhausted.

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Appendix A: List of Countries Included in the Dataset

Albania	Croatia	**Lao PDR**	Romania
Algeria	Cyprus	Latvia	Russian Federation
Argentina	Czechia	Lithuania	Rwanda
Armenia	Denmark	Luxembourg	[Saint Lucia]
Aruba	Dominican Rep.	Madagascar	Samoa
Australia	Ecuador	**Malaysia**	Sao Tome and Principe
Austria	Egypt	Maldives	Saudi Arabia
Azerbaijan	El Salvador	Malta	Senegal
Bahrain	Estonia	Mauritius	[Seychelles]
[Barbados]	Ethiopia	Mexico	**Singapore**
Belarus	Fiji	[Morocco]	Slovakia
Belgium	Finland	[Mozambique]	Slovenia
Belize	France	**Myanmar**	[Solomon Isds]
[Benin]	Georgia	Namibia	South Africa
Bolivia	Germany	Netherlands	Spain
Bosnia Herzegovina	Greece	**New Zealand**	Sri Lanka
[Botswana]	Greenland	Niger	State of Palestine
Brazil	Guatemala	Norway	Sweden
Brunei Darussalam	Guyana	[Oman]	Switzerland
Bulgaria	Hungary	**Other Asia, nes***	TFYR of Macedonia
[Burundi]	Iceland	Pakistan	**Thailand**
Cabo Verde	**India**	Panama	Tunisia
Cambodia	**Indonesia**	Paraguay	Turkey
[Cameroon]	Ireland	Peru	Uganda
Canada	Israel	**[Philippines]**	[United Arab Emirates]
Central African Rep.	Italy	Poland	United Kingdom
Chile	Jamaica	Portugal	United Rep. of Tanzania
China	**Japan**	[Qatar]	Uruguay
Colombia	Jordan	**Rep. of Korea**	United States
Costa Rica	Kazakhstan	Rep. of Moldova	**Viet Nam**

Notes: 120 countries listed above are included in the dataset constructed by combining trade statistics based on SITC Rev. 3 and Rev. 4, which is used for the overview of the world trade trends from 2001 to the latest year of 2016. Countries shown in brackets are not included in the dataset based only on SITC Rev. 4, which is used for the analysis focusing on the period 2011–2016. Data for 'Other Asia, nes' is treated as that for Taiwan. 17 East Asian countries of our interest are ASEAN+6 and Taiwan as highlighted in boldface type.

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