Expansion and Deepening of Production Networks[*1]

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Abstract

This paper aims to reveal the reality of the expansion and deepening of international production networks in the East Asia region using trade statistics. In East Asia, the trade of manufactured parts occurring within regional production networks of the machinery industry, among others, has expanded over past decades and has been steadily increasing despite the recent decline in global trade as a whole. In other words, the expansion of the manufactured parts trade through East Asian production networks has not plateaued. The robustness of the manufactured parts trade through East Asian production networks is underpinned by the increase in the amount of trade within the existing trade relationships. On the other hand, there is still much room for ASEAN countries to expand and deepen their participation in East Asian production networks and to establish trade relationships of more diverse manufactured parts with more diverse trading partners.

Keywords: East Asian production networks; trade by production stage; extensive and intensive margins of trade; diversification of exported goods and destinations
JEL Classification: F14, F23

I. Introduction

Since the recovery from the Great Trade Collapse triggered by the global financial crisis in 2008, a "slow trade" phenomenon has been observed in which the increase in world trade volume is sluggish compared to world income growth. Several recent empirical studies have confirmed the relative importance of structural factors, such as declining income elasticity of trade, as opposed to cyclical factors, as the main cause of slow trade. In particular, there is a view that the trade occurring within international production networks is stagnant, even though the world income increases, as the production networks become mature and the expansion of networks reaches a plateau. For example, Constantinescu, Mattoo, and Ruta (2015) and Hoekman (2015) point out the possibility that imports of intermediate goods have been sluggish due to an increase in the domestic supply capacity of intermediate goods along with economic development in emerging countries such as China, which used to be a

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"factory of the world." In addition, Nakajima, Takatomi, Mori, and Ohyama (2016) perform quantitative analysis and conclude that 70% of slow trade is accounted for by structural factors such as increasing in-house production of manufactured parts in China and the slowing expansion of Global Value Chains.

In this regard, the current paper attempts to clarify the actual situation of the expansion and deepening of international production networks in the East Asia region by making use of international trade statistics.[1] Specifically, we carefully analyze finely disaggregated trade data to examine (i) whether the expansion of trade occurring within the production networks in East Asia has plateaued, (ii) whether the trade within East Asian production networks is increasing due to the formation of new trade relationships or strengthened existing trade relationships, and (iii) whether new trade relationships are still being built in East Asian production networks and whether the web of trade relationships is continuing to expand.

Discussions on slow trade have been covered in the recent *White Paper on International Economy and Trade* (METI, 2016, 2017) and the *JETRO Global Trade and Investment Report* (JETRO, 2016), and the claim that the expansion of international production networks has plateaued is cited as most likely. However, as far as we know, it seems that the claim has been left alone without proper verification as to whether international production networks really are saturated. It is necessary to consider whether the claims emerging in the US and Europe are also applicable to the production networks that spread across East Asia. In order to fill such a gap, the current paper carefully analyzes product-level bilateral trade data and presents the facts regarding whether production networks have been saturated and the expansion of trade within the networks has plateaued.

Baldwin (2016) coins the term "first unbundling" to explain the spatial separation of production and consumption across borders due to the reduction in international transportation costs. The first unbundling means any international input-output relationships, including the trade of raw materials or primary goods. Since the beginning of the 1990s, in addition to reduced transportation costs, the ICT revolution has made it possible to spatially separate production stages of manufactured goods. Such cross-border fragmentation of production process is what Baldwin (2016) calls the "second unbundling." In the current paper, we would like to approach the reality of the expansion and deepening of international production networks based on the international division of labor at the production stage level, which corresponds to the second unbundling. We therefore will focus on the trade trends of manufactured parts, in particular, the trade occurring within the production networks, by utilizing bilateral trade data decomposed by stage in the production process.

The composition of the paper is as follows: section II outlines trends in the trade of manufactured parts using trade data by production stage and examines whether the expansion of manufactured parts trade within the international production networks in the East Asian region has plateaued, that is, whether East Asian production networks are getting saturated.

[1] In this paper, East Asia is defined as ASEAN+6, that is, the ASEAN member countries, China, Japan, Korea, Australia, New Zealand, and India, plus Taiwan.

From the perspective of the extensive and intensive margins of trade, section III examines whether the observed steady increase of trade within East Asian production networks is due to the expansion of the range of exported goods or trading partner countries, or due to the increase in shipments of the long-lived goods or partners. Section IV examines whether East Asian production networks continue to expand with newly exported goods or with newly-connected export partners, with emphasis on recent developments in ASEAN countries. Based on these analyses, section V concludes the actual situation of the expansion and deepening of East Asian production networks.

II. First look with trade data by production stage

This section examines whether the expansion of the manufactured parts trade within the international production networks in the East Asian region has plateaued. After describing the trade data decomposed by production stage that are used throughout the section, sections II-2 and II-3 outline the trade trends in the world and East Asia, respectively. Section II-4 investigates the East Asian machinery trade with a special focus on electric machinery and, for comparison, transport equipment. Furthermore, section II-5 examines whether China's role as an importer of manufactured parts is changing the East Asian electric machinery and transport equipment trade.

II-1. Data description

In this section, we scrutinize trade data using the Research Institute of Economy, Trade and Industry (RIETI) Trade Industry Database 2015 (RIETI-TID 2015), which provides international trade statistics by production stage for the period from 1990 to 2015.[2] The RIETI-TID associates the UN BEC (Broad Economic Categories) classification with the SNA (System of National Account) criteria and classifies all traded goods into the groups of "primary goods," "intermediate goods," and "final goods" according to stages of the production process. Intermediate goods are further divided into "processed goods" and "parts & components," while final goods are further divided into "capital goods" and "consumption goods." Thus, there are five product categories in total.[3]

In what follows, we will examine recent trends in trade occurring within international production networks and compare these trends to other trade flows. The trade within the production networks based on international division of labor at the production stage level includes not only the trade of manufactured parts but also the trade of finished products that are manufactured by assembling imported intermediate inputs or processing imported

[2] In the data analysis of this section, we use the same data set as in Matsuura and Obashi (2018). The basic contents of this subsection are reprinted from Matsuura and Obashi (2018) with some modification. From the next subsection onwards, we will conduct the detailed data observations that Matsuura and Obashi (2018) could not handle.

[3] For more information about product categories by production stage in the RIETI-TID 2015, see the RIETI webpage (http://www.rieti.go.jp/jp/projects/rieti-tid/pdf/1704.pdf).

semi-finished products. The former corresponds to the RIETI-TID product category of "parts & components," whereas the latter is included only as part of "capital goods" or "consumption goods." Notice that the product categories of "capital goods" and "consumption goods" include the final goods whose series of production process from upstream to downstream are carried out within a single country. We therefore focus particularly on the trade trend of "parts & components" that is considered to purely reflect the trade within the networks.

Indeed, the RIETI-TID product category of "processed goods" mainly includes (semi) processed raw materials to be used as intermediate inputs for chemical products (including plastic products), iron and steel, non-ferrous metals and metal products, petroleum and coal products, and related mining products. That is, "processed goods" can be regarded as chemical and mineral resource-related processed materials but not as parts, components, or semi-finished products manufactured and traded within international production networks observed in machinery and other industries. To be more precise, chemical and mineral resources-related processed raw materials account for 80% of the world trade of "processed goods" during the period of interest, 1990-2015. In contrast, less than 4% of the "processed goods" trade falls under intermediate goods used in the machinery industry during the same period.[4]

In addition, when examining the details of "parts & components" trade according to the RIETI-TID product definition, over 94% of the world trade of "parts & components" occurs in the machinery industries (such as general machinery, electric machinery, household electrical appliances, transport equipment, and precision machinery) throughout the period from 1990-2015. This paper broadly focuses on the "parts & components" trade as the trade occurring within international production networks and more specifically focuses on the cross-border transactions of machinery parts through the production networks in the machinery industries.

II-2. Overview of the world trade trends

The line graph in the upper part of Figure 1 shows the evolution of the world total value of all merchandise trade from 1990 to 2015, with the trade values decomposed into five product categories according to production stages. The vertical axis (both left and right) is the trade value expressed in constant US dollars (with 2000 as a base year) adjusted by the US import price index. The import structure of the US, a major importer in global trade, represents the trade structure of the whole world, so the US import price index is considered to be desirable as a deflator of world prices.[5] The line graphs in the lower part of Figure 1 examine trade trends by dividing the world total trade value into (A) East Asian intra-re-

[4] Industry classification is based on the classification adopted by RIETI-TID 2015 (including 13 industries). For more information, see the same RIETI webpage from the previous footnote.

[5] Ideally, price fluctuations should be controlled by industry, but there is no such disaggregated deflator, so here we use the US import price index to control overall price fluctuations. The US import price index can be obtained from the Bureau of Labor Statistics (BLS) webpage (https://www.bls.gov/mxp/).

gional trade, (B) East Asian exports to countries outside of the region, (C) East Asian imports from the outside, and (D) trade among countries outside East Asia. The line graphs then further divide each trade value into five product categories according to production stages, as in the upper part. In the data analysis of this section, ASEAN+6 and Taiwan are included as part of "East Asia."[6]

Table 1, which complements Figure 1, shows specific numerical values of trade trends at four points of year, 1990, 2000, 2011, and 2015. For each product category according to production stage, the following figures are shown: (a) the world and East Asian trade values at four points each year, (b) annual growth rates of the trade values in over the three periods of 1990-2000, 2000-2011, and 2011-2015, (c) product composition of the world and East Asian trade at four points each year, and (d) the proportions to the world total trade value of intra-East Asian trade, East Asian exports to the outside, and East Asian imports from the outside at four points each year. In Table 1, the five product categories are reorganized into three categories: "primary and processed goods," "parts & components," and "capital goods

Table 1. The world trade and the East Asian intra-regional and extra-regional trade, by production stage.

a) Trade value (billion US dollars, 2000)

	All merchandise, total				Primary and processed goods				Parts & components				Capital and consumption goods			
Year	1990	2000	2011	2015	1990	2000	2011	2015	1990	2000	2011	2015	1990	2000	2011	2015
World trade, total	3,295	5,884	11,631	11,327	1,468	2,303	5,832	4,884	490	1,167	1,703	1,872	1,337	2,414	4,096	4,572
A) Intra-East Asian trade	271	694	1,776	1,785	138	270	895	775	46	197	399	469	87	226	482	541
B) East Asian exports to outside	417	903	1,810	2,003	83	166	473	480	77	217	322	360	258	520	1,015	1,164
C) East Asian imports from outside	384	642	1,699	1,541	220	328	1,192	934	45	125	170	192	119	188	337	414
D) Trade outside East Asia	2,223	3,645	6,345	5,998	1,027	1,539	3,272	2,695	322	627	812	851	874	1,479	2,261	2,452

b) Annual average growth rate

	All merchandise, total			Primary and processed goods			Parts & components			Capital and consumption goods		
Period	90-00	00-11	11-15	90-00	00-11	11-15	90-00	00-11	11-15	90-00	00-11	11-15
World trade, total	6.0%	6.4%	-0.7%	4.6%	8.8%	-4.3%	9.1%	3.5%	2.4%	6.1%	4.9%	2.8%
A) Intra-East Asian trade	9.9%	8.9%	0.1%	6.9%	11.5%	-3.5%	15.8%	6.6%	4.1%	10.0%	7.1%	2.9%
B) East Asian exports to outside	8.0%	6.5%	2.6%	7.1%	10.0%	0.3%	11.0%	3.6%	2.8%	7.3%	6.3%	3.5%
C) East Asian imports from outside	5.3%	9.3%	-2.4%	4.1%	12.4%	-5.9%	10.6%	2.8%	3.2%	4.7%	5.4%	5.3%
D) Trade outside East Asia	5.1%	5.2%	-1.4%	4.1%	7.1%	-4.7%	6.9%	2.4%	1.2%	5.4%	3.9%	2.0%

c) Product composition, by trade flow

	All merchandise, total				Primary and processed goods				Parts & components				Capital and consumption goods			
Year	1990	2000	2011	2015	1990	2000	2011	2015	1990	2000	2011	2015	1990	2000	2011	2015
World trade, total	100%	100%	100%	100%	45%	39%	50%	43%	15%	20%	15%	17%	41%	41%	35%	40%
A) Intra-East Asian trade	100%	100%	100%	100%	51%	39%	50%	43%	17%	28%	22%	26%	32%	33%	27%	30%
B) East Asian exports to outside	100%	100%	100%	100%	20%	18%	26%	24%	18%	24%	18%	18%	62%	58%	56%	58%
C) East Asian imports from outside	100%	100%	100%	100%	57%	51%	70%	61%	12%	19%	10%	12%	31%	29%	20%	27%
D) Trade outside East Asia	100%	100%	100%	100%	46%	42%	52%	45%	15%	17%	13%	14%	39%	41%	36%	41%

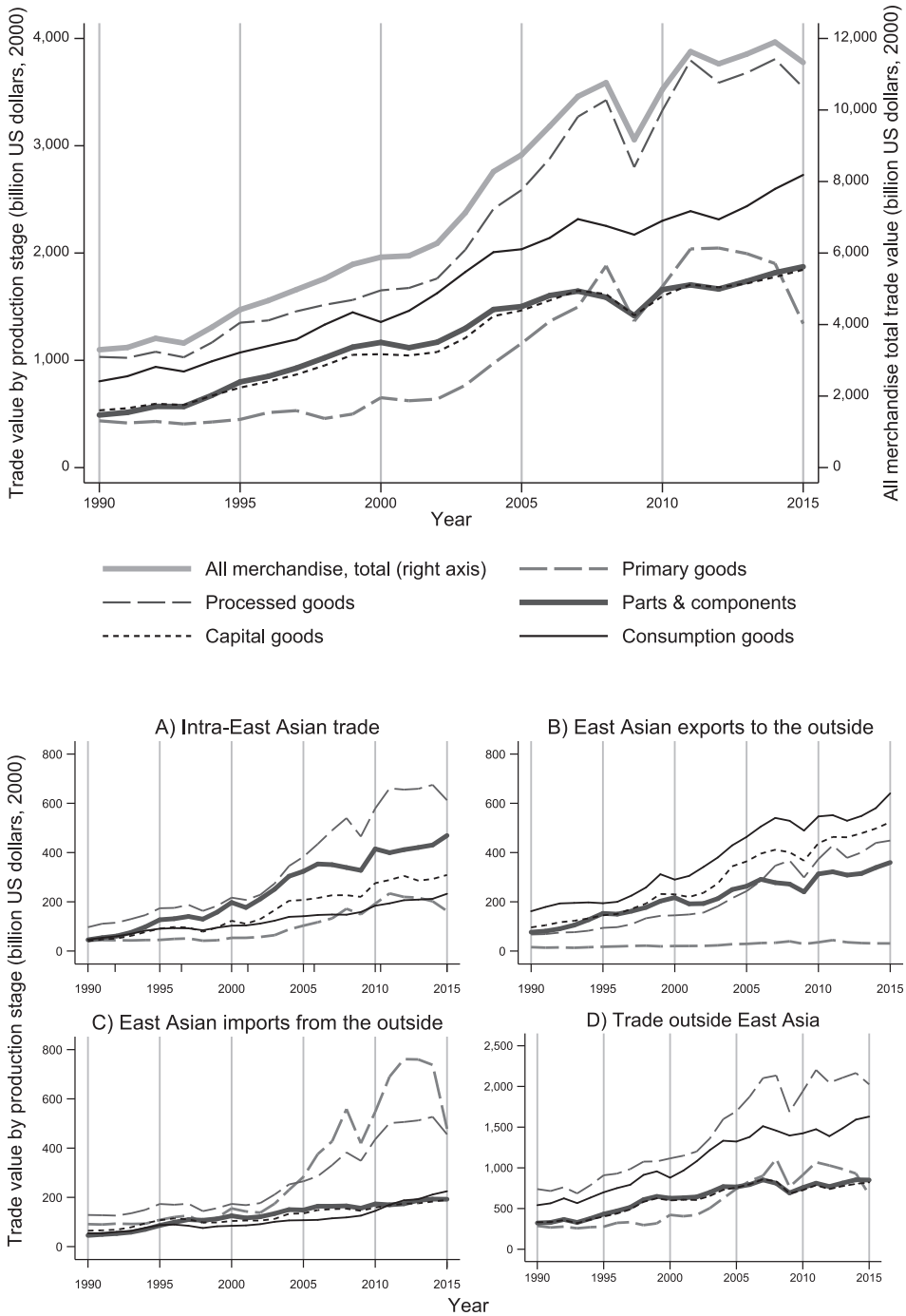
d) Trade flow composition, by product group

	All merchandise, total				Primary and processed goods				Parts & components				Capital and consumption goods			
Year	1990	2000	2011	2015	1990	2000	2011	2015	1990	2000	2011	2015	1990	2000	2011	2015
World trade, total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
A) Intra-East Asian trade	8%	12%	15%	16%	9%	12%	15%	16%	9%	17%	23%	25%	6%	9%	12%	12%
B) East Asian exports to outside	13%	15%	16%	18%	6%	7%	8%	10%	16%	19%	19%	19%	19%	22%	25%	25%
C) East Asian imports from outside	12%	11%	15%	14%	15%	14%	20%	19%	9%	11%	10%	10%	9%	8%	8%	9%
D) Trade outside East Asia	67%	62%	55%	53%	70%	67%	56%	55%	66%	54%	48%	45%	65%	61%	55%	54%

Note: See the notes of Figure 1.
Source: Reprinted from Matsuura and Obashi (2018) with some modification.

[6] Laos and Myanmar are not included because of data limitations. Brunei and Cambodia are included as part of East Asia, but data for Brunei as an importer in 1995, 1996, 1999, 2000, 2005, 2007-2011 and for Cambodia as an importer between 1990-1999 are missing in the RIETI-TID. Data for China includes only mainland China. Although the RIETI-TID includes Hong Kong as an individual area, we exclude Hong Kong export and import data when constructing a data set in view of the importance of Hong Kong's role as intermediary trade destination.

Figure 1. Evolution of the world trade (top) and the East Asian intra-regional and extra-regional trade (bottom), by production stage.



Notes: East Asia includes ASEAN+6 and Taiwan. Trade values are in constant US dollars deflated by the US import price index. The definition of the product categories by production stage is in accordance with the RIETI-TID.

Source: Reprinted from Matsuura and Obashi (2018) with some modification.

and consumption goods." "Processed goods" are added to "primary goods" because the former mainly includes processed materials related to chemicals and mineral resources. The finished product group combines the final goods of "capital goods" and "consumption goods."

As shown in the line graph at the top of Figure 1 and Panel a) in Table 1, the total value of all world merchandise trade (solid line in light gray on the graph, see the unit of the right axis) has increased 3.4 times, from $3.3 trillion in 1990 to $11.3 trillion in 2015. Looking at the trade values by production stage, "parts & components" (solid line in dark gray) increased most significantly from $490.1 billion to $1.9 trillion (3.8 times), doubling most rapidly in the 1990s. We can observe that world trade has expanded during the past few decades, driven by active transactions of manufactured parts through cross-border fragmentation of production.

The global financial crisis resulted in trade volumes shrinking across the world from 2008 to 2009, but trade volumes recovered soon thereafter. Behind the so-called Great Trade Collapse, the sharp drop followed by V-shape recovery of the "primary goods" (long dotted line in middle gray) and the "processed goods" (long dotted line in dark gray) stand out. On the other hand, the world trade of "parts & components," "capital goods" (short dotted line in black), and "consumption goods" (solid line in black) has begun to decline since 2007, showing a relatively gentle V-shape. As cross-border fragmentation of production progresses, manufactured parts and raw and processed materials, which are used as intermediate inputs in the production process, will cross borders more than once before reaching the consumers (or companies) as a finished product. This means, as discussed by Yi (2009) and others, that a drop in the final demand leads to a significant reduction in the trade volume of the associated intermediates, more than directly reducing the trade volume of the finished products. Nevertheless, it is noteworthy that the degree of the trade decrease of "parts & components" at the time of the global financial crisis is limited compared to "primary goods" and "processed goods."

Since 2011, following the recovery from the Great Trade Collase, the world's total merchandise trade has remained almost unchanged, and it has often been pointed out as a "slow trade" phenomenon. As shown in Panel b) of Table 1, the growth rate of the world's total trade during the period from 2011-2015 is -0.7% on an annual average. A slight decrease is even observed in 2012 and 2015. Two salient features of the recent world trade trends can be pointed out. First, as apparent from the comparison of trade trends by production stage shown in the upper line graph of Figure 1, most of the decline in trade in recent years is attributed to the fluctuation of trade values of "primary goods" and "processed goods." As can be confirmed in Panel b) of Table 1, the trade value of "primary and processed products" combining the above two decreased at an annual average rate of -4.3% from 2011 to 2015. Particularly noticeable is the recent decline in the trade value of "primary goods," part of which can be explained by the impact of the resource price plunge since around 2014.

Second, the world trade of "parts & components," "capital goods," and "consumption goods" has a lower growth rate than before the Great Trade Collapse; however, it is still

steadily increasing in recent years, in contrast to "primary goods" and "processed goods." As summarized in Panel b) in Table 1, the trade value of "parts & components" has been increasing with an annual average growth rate of 9.1% in the 1990s and 6.7% in the period from the IT bubble in 2001 to 2008. Since 2011, the annual average growth rate has fallen to 2.4%. Similar trends are observed for the finished products: the annual average growth rate of "capital goods and consumption goods" is 6.1% in the 1990s and 7.9% from 2001 to 2007. However, the rate has fallen to 2.8% since 2011 onwards.

In brief, behind the fact that the world total value of all merchandise trade is almost flat in recent years, there are contrasting changes: the trade in manufactured parts and finished products is steadily increasing while the trade in raw and processed materials is decreasing.

II-3. Overview of the East Asian trade trends

Considering these two features of recent world trade trends, the line graphs at the bottom of Figure 1 compare trade flows in East Asia with those outside the region. Note that the scale of the vertical axis is different among subgraphs A, B, C and D because we are interested in whether there is a characteristic difference in the transition of the trade value between product categories/stages in each trade flow. As mentioned above, specific numerical values corresponding to the subgraphs of Figure 1 are reported in Table 1.

As shown in Panel a) of Table 1, the all merchandise trade among East Asian countries has increased 6.6-fold from $270.7 billion in 1990 to $ 1.8 trillion in 2015. Meanwhile, the merchandise trade between countries outside East Asia experienced only a slight increase of 2.7 times from $2.2 trillion in 1990 to $ 6.0 trillion in 2015. The corresponding changes in East Asian exports to the outside and East Asian imports from the outside show intermediate rates of growth of 4.8 and 4.0 times, respectively. Above all, the East Asian intra-regional trade of "parts & components" (dark gray solid line in subgraph A) has increased significantly by more than 10 times from $45.6 billion in 1990 to $469.2 billion in 2015; in particular, the trade value quadrupled in the 1990s. In contrast, the "parts & components" trade outside East Asia (dark gray solid line in subgraph D) has only increased 2.6-fold over the past few decades, from $322.4 billion to $850.8 billion; this growth rate is far below that of the East Asian exports and imports of "parts & components" with the outside.

As a result, as shown in Panel d) of Table 1, East Asian intra-regional trade, exports to outside the region, and imports from outside the region accounted for one-third of the world total trade value in 1990, but the proportion has risen to a half in 2015. It appears that the presence of East Asian countries in world trade has been increasing over the past few decades. Such a tendency is particularly noticeable in the manufactured parts trade. The proportion of intra-East Asian trade in the world trade of "parts & components" has doubled from 9% in 1990 to 17% in 2000 and has increased to 25% in 2015. On the other hand, the corresponding proportion of the trade outside East Asia has fallen from 66% in 1990 to 54% in 2000 and further to 45% in 2015. As for East Asian exports and imports with the outside, the proportion has been around 16-19% and 9-11%, respectively. East Asian countries have

significantly increased trade of manufactured parts, intensively with neighboring partners inside the region. These observations suggest the development of international production networks in East Asia over the past few decades and the expansion of manufactured parts trade through the networks.

The decline in trade of raw and processed materials, which is one of the two features observed in the world trade trends since 2011, is commonly observed for all disaggregated trade flows as well. As can be confirmed from Panel b) in Table 1, the total merchandise trade value for each trade flow is decreasing or remains almost unchanged, with annual average rate of change ranging from -2.4% to 0.1%, in the period from 2011-2015, except for East Asian exports to outside the region. These recent declines in trade are accounted for mainly by the decline in the trade of raw and processed materials. The trade of "primary and processed goods" has been decreasing at an annual average rate ranging from -3.5% to -5.9%, since 2011. Exceptionally, for East Asian exports to the outside, although the trade value of "processed goods" (dark gray long dotted line in subgraph B) is up and down, it is consistently increasing. And overall, the East Asian exports of all merchandise to the outside has been increasing at an annual average growth rate of 2.6% since 2011.

A steady increase in the trade of manufactured parts and finished products, the other feature observed as the recent world trade trends, is also commonly observed for all disaggregated trade flows. However, we can find a different trend between trade flows as to how much the growth rate is lower than before the Great Trade Collapse. First of all, for East Asian imports from outside the region, the import growth of "consumption goods" (black solid line in subgraph C) has not slowed down since 2011. The annual average growth rate of "capital goods and consumption goods" is shown in Panel b) of Table 1. East Asian imports of finished products from the outside has increased at almost constant rate of annual average growth: 5.4% during the period from 2000-2011 and 5.3% from 2011 onwards. If calculating the annual average growth rate of "consumption goods" exclusively, the imports has increased at even faster pace of 7.2% since 2011, exceeding the rate of 6.6% in the period from 2000-2011. East Asian imports of final consumption goods from the outside have been in the accelerating trend rather than slowing down the growth rare since 2011 and have not fallen amid the Great Trade Collapse. This can be regarded as a fact that supports the strong import demand for final consumption goods in East Asian countries.

More importantly, the strong increase in manufactured parts trade that continues even after 2011 is particularly noticeable in East Asian intra-regional trade. As summarized in Panel b) in Table 1, the intra-East Asian trade value of "parts & components" has been rapidly increasing at an annual average rate of 15.8% in the 1990s and at 12.1% during the period from 2001-2007, with the progress of the international production network in the region. Since 2011, when recovered from the Great Trade Collapse, intra-East Asian "parts & components" trade has steadily increased at an annual average rate of 4.1%, although the growth rate is relatively lower than the period from the 1990s to the early 2000s when East Asian production networks have expanded significantly. With the expansion of world merchandise trade slowing down, the annual average growth rate of 4.1% is the second highest,

when comparing by trade flow and product category, following 5.3% recorded for East Asian imports of "capital goods and consumption goods" from outside the region. Focusing on the latest changes from 2014 to 2015, while the "parts & components" trade among countries outside East Asia has fallen slightly by 0.3% and is still sluggish, the intra-East Asian "parts & components" trade is increasing at a high growth rate of 9.0%. Although verification using data from 2016 onwards is awaited, it can be regarded as a fact showing the sign that manufactured parts trade through East Asian production networks is strongly recovering.

These observations of the world and East Asian trade trends reveal that the trade of raw and processed materials has declined worldwide since 2011, whereas the trade of manufactured parts and finished products has steadily increased. In particular, the solid increase in manufactured parts trade and the recent upward trend is a prominent feature of the East Asian region, suggesting the robustness of manufactured parts trade through the regional production networks.

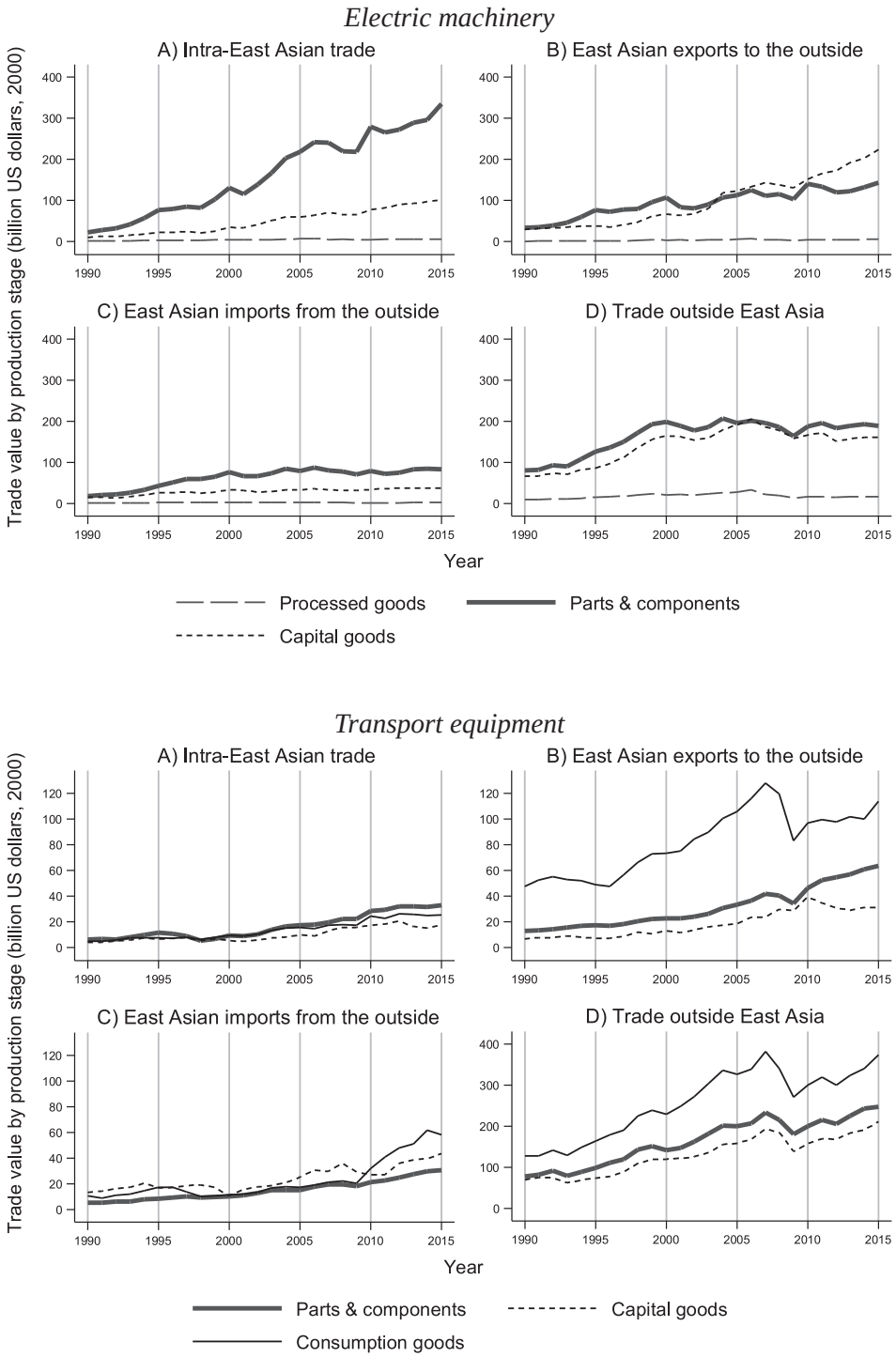
II-4. Trend in East Asian machinery trade: electric machinery and transport equipment

Most of the "parts & components" this paper focuses on are manufactured parts used as intermediate inputs in the machinery industries, as mentioned in section II-1. The observed facts on trade tends in the previous sections show that the trade of machinery parts through international production networks has expanded over the past few decades and continues to steadily expand since 2011 in the East Asian region. In this section, we will investigate the trends in the manufactured parts trade through East Asian production networks, comparing the electrical machinery and transport machinery industries.

Similar to the line graphs in the lower part of Figure 1, Figure 2 shows the evolution of trade values by dividing the world trade of electric machinery and transport equipment into four trade flows, including East Asian intra-regional trade, and by decomposing each trade flow according to production stage. Although there are five product categories, transactions in the electrical machinery industry include only those classified under "processed goods," "parts & components" or "capital goods" as defined in the RIETI-TID. Therefore, there are only three lines shown on each subgraph. Similarly, it should be noted that transactions in the transport equipment industry include, by definition, those fallen under "parts & components," "capital goods" or "consumption goods."

The East Asian intra-regional trade value of "parts & components" in the electrical machinery industry (dark gray solid line in subgraph A, the upper part of Figure 2) has increased by 15 times from 1990 to 2015. It recorded a high annual average growth rate of 19.0% in the 1990s and 13.1% from 2001-2007; growth has been steadily increasing at an annual average rate of 6.0% since 2011. In particular, it has most recently increased by 12.8% from 2014 to 2015, and the difference with the electrical machinery "parts & components" trade among countries outside East Asia is striking: the latter has been stagnant since the 2000s. The manufactured parts trade through the East Asian production networks in the

Figure 2. Evolution of East Asian intra-regional and extra-regional trade of electric machinery and transport equipment.



Note: See the notes of Figure 1.
Source: Author's calculation using the RIETI-TID 2015.

electrical machinery industry seems to be recovering strongly.

In contrast to electrical machinery, the East Asian intra-regional trade value of "parts & components" in the transport equipment industry (dark gray solid line in subgraph A, the lower part of Figure 2) stagnated during the Asian currency crisis; the annual average growth rate then rebounded to 14.1% from 2001-2007. Even after the Great Trade Collapse, the annual average growth rate has stagnated at 2.8% since 2011. On the other hand, for East Asian exports to and imports from outside the region as well as trade among countries outside East Asia, the transport equipment "parts & components" trade has been on a relatively increasing trend since 2011. It should be noted, however, that the scale of the vertical axis is different between the corresponding subgraphs of electrical machinery and transport equipment, except for the trade outside East Asia (subgraph D). As is clear from the scale differences on the vertical axis, the intra-East Asian trade value of electrical machinery "parts & components" since 2015 is more than 10 times that of transport equipment "parts & components." The presence of the electrical machinery "parts & components" trade inside the East Asian region stands out in terms of the relative magnitude to other product categories such as finished products. Furthermore, the proportion of intra-East Asian trade in the world total trade of electric machinery "parts & components" has reached nearly half, and this proportion rises to three quarters if East Asian exports and imports outside the region are also included.

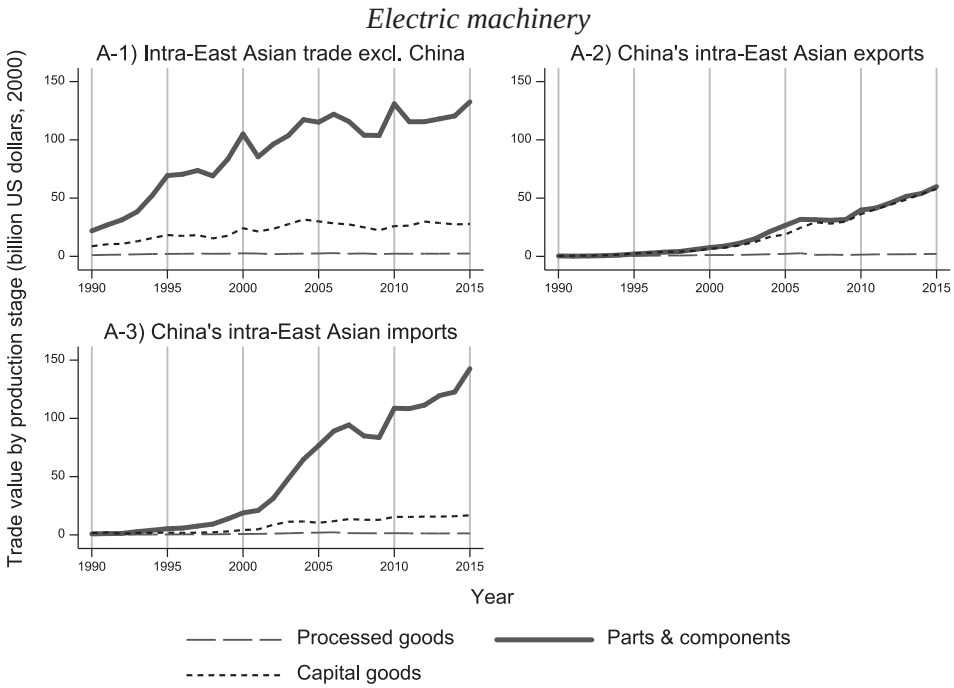
The steady increase in the manufactured parts trade stands out among the world, especially in the East Asian region. Underpinning that is the strong growth of East Asian intra-regional trade in the machinery industries, especially that of electric machinery parts and components. At least the expansion of manufactured parts trade through East Asian production networks in the electrical machinery industry has not plateaued.

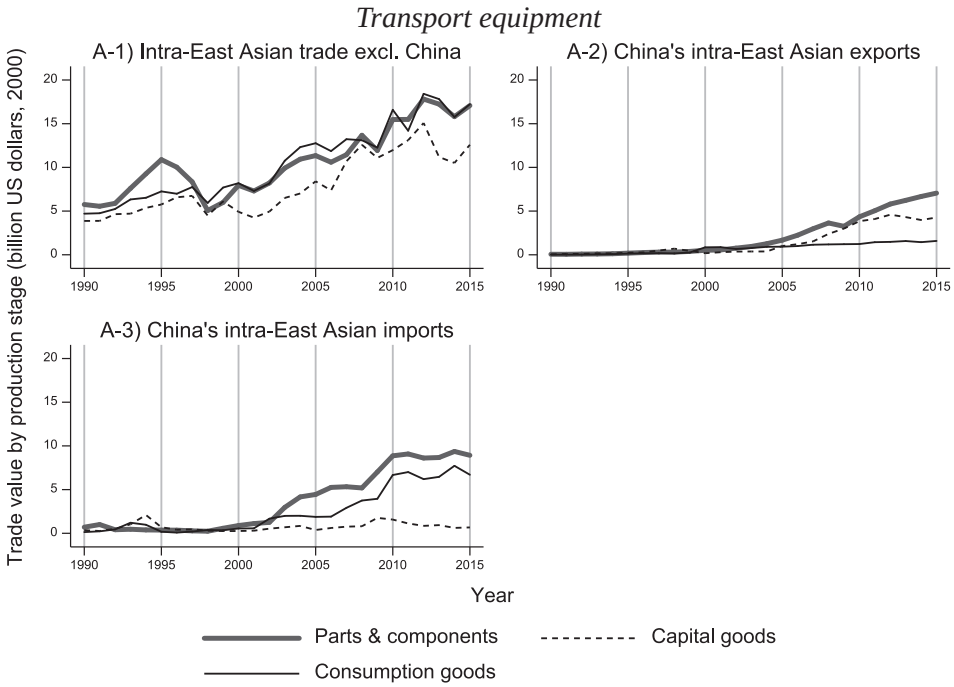
II-5. Changing role of China in intra-East Asian machinery trade

In the slow trade debate, the possibility has been pointed out that the domestic supply capacity of intermediate goods has risen in China, which used to be a "factory of the world," and that China's imports of intermediate goods has switched to domestic procurement, causing worldwide trade stagnation (Constantinescu et al. 2015; Hoekman, 2015; Nakajima et al., 2016). In this subsection, we will examine whether the observed stagnating trend of East Asian intra-regional trade of electric machinery parts is due to China switching to domestic procurement of goods that used to be imported from East Asian trading partner countries. If China's role as a parts importer is truly undergoing such a change, the strong increase in manufactured parts trade through the East Asian production networks of the electrical machinery industry observed in the previous section would be expected to plateau gradually in the future.

Figure 3 shows the trade trends by production stage, dividing the East Asian intra-regional trade of electrical machinery into A-1) trade among East Asian countries excluding China, A-2) China's exports to other East Asian countries, and A-3) China's imports from

Figure 3. The presence of China in the East Asian intra-regional trade of electric machinery and transport equipment.





Note: See the notes of Figure 1.
Source: Author's calculation using the RIETI-TID 2015.

other East Asian countries. As in the previous section, we will also focus on the trade trends of the transport equipment industry as a comparison for the electrical machinery industry.

First, looking into the trend in the East Asian intra-regional trade of electrical machinery "parts & components," although the trade among East Asian countries other than China (dark gray solid line in subgraph A-1, the upper part of Figure 3) has increased rapidly in the 1990s, China's exports to and imports from other East Asian countries (dark gray solid lines in subgraphs A-2 and A-3) have been growing at an annual average growth rate over 36% but have remained at extremely limited levels. As of 2000, China's exports and imports of electrical machinery "parts & components" with other East Asian countries is merely less than a quarter of the value of the electrical machinery "parts & components" trade between East Asian countries other than China. In the 2000s, while the expansion of the electrical machinery "parts & components" trade between East Asian countries other than China has slowed, China's imports from other East Asian countries have continued to grow at an annual average rate of 28.4% from 2001 to 2007, achieving a remarkable increase. Even after the Great Trade Collapse, the China's imports have continued to increase at an annual average rate of 7.1% since 2011, especially increasing by 16.3% from the most recent 2014 to 2015. Similar high growth is also observed for China's exports of electric machinery "parts & components" to other East Asian countries. China's exports and imports of electric machinery "parts & components" together expanded explosively by more than 170 times during the period from 1990- 2015. The proportion of the China's exports and imports in the intra-East Asian trade of electric machinery "parts& components" has reached 40% and 20%, respectively.

The strong growth of the East Asian intra-regional trade of electric machinery parts can be seen to have been driven by the sharp rise in China's imports from other East Asian countries, especially since the 2000s. Even after 2011, China's import demand for electric machinery parts from other East Asian countries does not seem to be declining. At the same time, the fact that China is rapidly increasing the exports of electric machinery parts to other East Asian countries, though the magnitude is less than half of imports, suggests a growing domestic supply capacity in China. At least in the East Asian production networks of the electrical machinery industry there is no fact that supports the concern that the domestic supply capacity of manufactured parts is increasing in China and its demand for imported parts is decreasing.

In addition, looking at the trade trends other than "parts & components," the trade value of electric machinery "capital goods" has been almost flat over the past few decades in trade among East Asian countries other than China and for China's imports from other East Asian countries (black short dotted lines in subgraphs A-1 and A-3). On the other hand, China's exports of electric machinery "capital goods" to East Asian countries (black short dotted line in subgraph A-2) has achieved continuous high growth, almost in line with the "parts & components" exports. In East Asian production networks of the electrical machinery industry, China's role as a "factory of the world" appears to be still important.

Looking at the trends in China's exports and imports of transport equipment parts with

other East Asian countries as a comparison target, the difference from the electrical machinery parts trade is striking. China's imports of transport equipment "parts & components" from other East Asian countries (dark gray solid line in subgraph A-3, the lower part of Figure 3) are smaller by an order of magnitude than the electric machinery parts, but an annual average growth rate reaches 29.8% during the period from 2001-2007. Since recovery from the Great Trade Collapse, however, it is clearly stagnant. The annual average growth rate since 2011 is slightly negative at -0.4%, in contrast to the continued increase in China's imports of electric machinery parts. At the same time, China's exports of transport equipment "parts & components" to other East Asian countries (dark gray solid line in subgraph A-2) have continued to increase at an annual average rate of 8.7% since 2011, and they are approaching the level of the corresponding imports. On the other hand, China's exports of "capital goods" and "consumption goods" to other East Asian countries (black short dotted line and solid line in subgraph A-2) have stagnated since 2011. It is suggested from these observed facts that China's presence as a "factory of the world" is diminishing in the East Asian production networks of the transport equipment industry, unlike electric machinery, and that manufactured parts imported from neighboring East Asian countries may have been switched to domestic procurement along with the rise of domestic supply capacity in China.

III. Examination of the extensive and intensive margins of trade

In what ways has the expansion of the manufactured parts trade within international production networks in the East Asian region been achieved? This section examines whether trade within these networks has increased due to the formation of new trade relationships or due to an increase in magnitude of the existing trade relationships. The former is referred to as the "extensive margin" of trade, and the latter is referred to as the "intensive margin." The next subsection first explains the method of decomposing the change in the amount of trade into the extensive and intensive margins. Section II-2 then looks into the extensive and intensive margins of trade behind the two features observed for the world and East Asian trade trends since 2011 onwards in the previous section; in particular, the steady increase of manufactured parts trade through East Asian production networks is reviewed. Section III-3 further examines the extensive and intensive margins of the East Asian intra-regional trade of manufactured parts since 2011 and compares them with the trends in the early 2000s.

III-1. Decomposing trade into extensive and intensive margins

In this section, we decompose the change in the amount of trade into the change at the extensive and intensive margins according to the method adopted in Behrens et al. (2013) and Ariu (2016). We begin by briefly describing the decomposition method. First, let X_k be the total trade value for a type of trade flow in a product category for a given year. Here, for simplicity, ignoring a subscript for year, k will indicate a specific type of trade flow at the product category level. The total trade value X_k of type k can be rewritten as in equation (1),

as the product of the number of exporting countries (c_k), the average number of export destination countries per exporting country ($\bar{d}_k$), the average number of exported goods per origin and destination country pair ($\bar{p}_k$), and the average export value per origin-destination-product triplet ($\bar{x}_k$).

$$X_k \equiv c_k \cdot \bar{d}_k \cdot \bar{p}_k \cdot \bar{x}_k \tag{1}$$

The change in the trade value in a given period is defined as $\Delta X_k \equiv X_k / X_k'$, where X_k' is the amount of trade in the initial year. Similarly, if changes in the corresponding period are defined using Δ for all terms on the right side of equation (1), the total changes in the trade value X_k are divided into individual changes and can be represented as

$$\Delta X_k = \Delta c_k \cdot \Delta \bar{d}_k \cdot \Delta \bar{p}_k \cdot \Delta \bar{x}_k. \tag{2}$$

By taking the logarithm of both sides of equation (2), it is possible to calculate the contributions of the extensive and intensive margins to the total changes of the trade value X_k.

$$1 = \frac{\ln \Delta c_k}{\ln \Delta X_k} + \frac{\ln \Delta \bar{d}_k}{\ln \Delta X_k} + \frac{\ln \Delta \bar{p}_k}{\ln \Delta X_k} + \frac{\ln \Delta \bar{x}_k}{\ln \Delta X_k} \tag{3}$$

On the right side of equation (3), the first three terms correspond to the contributions to trade growth at extensive margins of changes in the number of exporting countries, the average number of destination countries, and the average number of exported goods. The last term corresponds to the growth contribution at the intensive margin of the change in average export value.

III-2. Margins of East Asian intra-regional and extra-regional trade since 2011

Using the decomposition method described in the previous subsection, Obashi and Kimura (2018) analyze the contribution of the extensive and intensive margins to the world and East Asian trade growth from 2011 to 2016. In this subsection, we introduce the major findings of Obashi and Kimura (2018) and confirm that the intensive margin plays an important role behind the two features observed for the recent trade trends from the previous section. In particular, we will point out that the steady increase in the manufactured parts trade through East Asian production networks is underpinned by the increase in the average trade value at the intensive margin.

In Table 2, reproduced from Obashi and Kimura (2018), the changes in the world total value of all merchandise trade from 2011 to 2016 are decomposed into changes at the extensive and intensive margins by production stage and by trade flow type. As in the previous section, we adopt product categories according to production stages based on the RIETI-TID product definition and disaggregate world trade into four trade flows, such as East Asian intra-regional trade.[7] Changes in the total trade value for a certain flow in a certain product category are broken down into changes at the extensive margins of the number of exporting countries, the average number of destination countries per exporting country, the average

Table 2. Extensive and intensive margins of East Asian intra-regional and extra-regional trade by production stage: 2011-2016.

		Changes at extensive margins							Changes at intensive margin		
	Annual average trade growth	Number of exporting countries	Average number of destination countries			Average number of exported goods per origin-destination pair			Average export value (million US dollars) per origin-destination-product triplet		
	2011-16	2011-16	2011	2016	Annual average growth [Contribution]	2011	2016	Annual average growth [Contribution]	2011	2016	Annual average growth [Contribution]
Primary goods											
Intra-East Asian 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%]
East Asian 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%]
East Asian 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 East Asia	-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%]
Processed goods											
Intra-East Asian 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%]
East Asian 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%]
East Asian 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 East Asia	-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%]
Parts & components											
Intra-East Asian 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%]
East Asian 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%]
East Asian 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 East Asia	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%]
Capital goods											
Intra-East Asian 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%]
East Asian 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%]
East Asian 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 East Asia	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%]
Consumption goods											
Intra-East Asian 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%]
East Asian 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%]
East Asian 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 East Asia	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%]

Notes: The sample includes 106 countries for which trade data based on the SITC Rev. 4 are available in 2011 and 2016. Among them, East Asia includes ASEAN+6 (except the Philippines) and Taiwan (16 countries/regions). Trade values are in constant US dollars deflated by the US import price index. The definition of product categories by production stage is in accordance with RIETI-TID. The maximum number of exported goods is 250 for primary goods, 1,307 for processed goods, 260 for parts & components, 458 for capital goods, and 691 for consumption goods.
Source: Reprinted from Obashi and Kimura (2018) with some modification.

[7] Trade data provided on the RIETI-TID website is aggregated for each of the five product categories by production stage: "primary goods," "processed goods," "parts & components," "capital goods," and "consumption goods." However, a correspondence table is available that summarizes how each item code is classified under which product category at the most disaggregated level of the Standard International Trade Classification (SITC) Rev. 3 and Rev. 4. Obashi and Kimura (2018) use this correspondence table to identify production stages for all 2,966 items at the finest level of SITC Rev. 4.

number of exported goods per origin-destination country pair and changes at the intensive margin of the average export value per origin-destination-product triplet. Table 2 shows the annual average growth rate of the total trade value during the period from 2011-2016, the number of exporting countries, the average number of destination countries in 2011 and 2016 with its annual average rate of change, the average number of exported goods in the two points per year and its annual average rate of change, and the average export value in the two points of year and its annual average rate of change, for each trade flow in each product category. As in the previous section, the trade values are shown in constant US dollars deflated by the US import price index. As for the number of exporting countries, the figures are not reported for respective years because they did not change during the period of interest for any of the disaggregated trade flows by product category. In addition, the contribution of the change of concern to the total changes of the total trade value is shown in square brackets below the annual average growth rate.

Our sample includes 106 countries for which trade data based on SITC Rev. 4 are available for both 2011 and 2016. Among them, "East Asia" includes 16 countries/regions, including ASEAN+6 (except the Philippines due to data limitations) and Taiwan. The maximum possible number of exporting countries and destination countries, respectively, is 16 and 15 for East Asian intra-regional trade, 16 and 90 for East Asian exports to outside the region, 90 and 16 for East Asian imports from the outside, and 90 and 89 for trade among countries outside East Asia. The number of exported goods is counted at the finest level of SITC Rev. 4; there are 250 items of "primary goods," 1,307 items of "processed goods," 260 items of "parts & components," 458 items of "capital goods," and 691 items of "consumption goods" at maximum.

A comparison of the contributions of the extensive and intensive margins to the trade growth shows that the decrease in the trade value of raw materials since 2011 and the stagnation in the trade growth of processed materials are both caused mainly by the decrease in the average trade value at the intensive margin. On the other hand, the trade of manufactured parts and finished products are steadily increasing despite the fact that the world total value of all merchandise trade is almost unchanged. Furthermore, the contribution to trade growth due to the rise of the average number of destination countries and the number of exported goods at the extensive margins is not negligible. Nevertheless, an increase in the average trade value at the intensive margin contributes more to the trade growth of manufactured parts and finished products, compared to the contribution of the extensive margins. Such importance of the intensive margin of trade is particularly noticeable in East Asian intra-regional trade and East Asian exports to outside the region. In fact, 80.0% of the increase in the intra-East Asian trade value of "parts & components" is attributed to the contribution of the intensive margin. It appears that the strength of manufactured trade within East Asian production networks, which has been steadily increasing even since 2011, is underpinned by an increase in the average trade value of the once established trade relationships.

III-3. Margins of intra-regional manufactured parts exports by East Asian countries

The steady increase in the manufactured parts trade within East Asian production networks has been mainly underpinned by an increase in trade volumes of existing trade relationships. Is such importance of the intensive margin of trade observed for the exports of manufactured parts by respective East Asian countries to neighboring trading partners as well? In view of the diversity of the East Asian region, where countries at various economic development stages coexist, the export growth patterns through participating in the regional production networks are expected to also differ across countries, for example, between China and the ASEAN latecomer countries. In this section, using the same data set introduced in the previous section from Obashi and Kimura (2018), we analyze the expansion paths of intra-regional manufactured parts exports by East Asian countries in recent years, identify characteristic trends among the countries, and compare them with the trends in the first half of the 2000s.

Table 3 shows changes in intra-regional "parts & components" exports by East Asian countries from 2011 to 2016. This is shown by decomposing exports into changes at the extensive margins of the number of destination countries, the average number of exported goods per destination country and changes at the intensive margin of the average export value per destination-product pair. As in Table 2, ASEAN+6 (except the Philippines) and Taiwan are included as "East Asia." Table 3 shows the total intra-East Asian export value of "parts & components" in 2011 and 2016 and its annual average growth rate during the period from 2011-2016, the number of destination countries and its annual average rate of change, the average number of exported goods and its annual average rate of change, and the average export value and its annual average rate of change. The contribution to the total change in total export values is shown in square brackets under the annual average growth rate. To make it easier to sort out the trends in the expansion path of manufactured parts exports, the exporting countries on the left-most column are listed in descending order of the total intra-East Asian "parts & components" export values in 2016, dividing into groups of ASEAN countries, Northeast Asian countries, and other East Asian countries. In addition, because 16 East Asian countries/regions are included in our analysis, the number of destination countries of each exporting country is up to 15. As for the number of exported goods, the actually exported codes corresponding to "parts & components" based on the RIETI-TID definition are counted at the finest level of SITC Rev. 4, and the number is up to 260.

First, as is clear from comparing the export values of East Asian countries, the intra-East Asian trade of manufactured parts is led by Taiwan, China, Korea, and Japan. Each of these Northeast Asian countries exports to all 15 destination countries in the region. Looking at the average number of exported goods per destination country, even Taiwan, with the fewest goods exported on average, exports 70% or more of the items existing in the statistics to its neighboring partners. China exports more than 90% of the statistically existing items. The Northeast Asian countries have led the formation of trade relationships of various manufac-

Table 3. Extensive and intensive margins of intra-regional manufactured parts exports by East Asian countries: 2011-2016.

	Export value (million US dollars)			Changes at extensive margins: Number of destinations (max: 15)			Changes at extensive margins: Average number of exported goods per destination (max: 260)			Changes at intensive margin: Average export value per destination-product pair (thousand US dollars)		
	2011	2016	Annual average growth rate	2011	2016	Annual average growth [Contribution]	2011	2016	Annual average growth [Contribution]	2011	2016	Annual average growth [Contribution]
ASEAN countries												
Malaysia	43,654	47,689	1.8%	15	15	0.0% [0.0%]	172.3	178.1	0.7% [37.9%]	16,894	17,848	1.1% [62.1%]
Thailand	19,429	25,444	5.5%	15	15	0.0% [0.0%]	182.6	194.7	1.3% [23.9%]	7,094	8,711	4.2% [76.1%]
Singapore	24,155	22,602	-1.3%	15	15	0.0% [0.0%]	192.2	192.3	0.0% [-1.0%]	8,378	7,834	-1.3% [101.0%]
Vietnam	4,035	19,431	36.9%	15	15	0.0% [0.0%]	118.0	147.8	4.6% [14.3%]	2,280	8,765	30.9% [85.7%]
Indonesia	6,279	6,649	1.2%	15	15	0.0% [0.0%]	137.3	142.6	0.8% [65.8%]	3,048	3,108	0.4% [34.2%]
Cambodia	2	274	163.9%	11	14	4.9% [5.0%]	13.3	20.3	8.9% [8.7%]	15	964	131.0% [86.3%]
Laos	8	231	97.8%	8	13	10.2% [14.2%]	9.0	12.3	6.5% [9.2%]	106	1,442	68.6% [76.6%]
Myanmar	10	45	35.8%	11	12	1.8% [5.7%]	17.7	24.5	6.7% [21.2%]	50	154	25.1% [73.2%]
Brunei	16	36	17.1%	11	12	1.8% [11.0%]	16.5	18.2	2.0% [12.6%]	90	164	12.8% [76.4%]
Northeast Asian countries												
Taiwan	74,620	123,211	10.5%	15	15	0.0% [0.0%]	189.7	191.9	0.2% [2.3%]	26,219	42,797	10.3% [97.7%]
China	82,341	118,320	7.5%	15	15	0.0% [0.0%]	233.5	239.5	0.5% [7.0%]	23,512	32,940	7.0% [93.0%]
Korea	72,855	108,287	8.2%	15	15	0.0% [0.0%]	188.7	195.9	0.8% [9.4%]	25,735	36,845	7.4% [90.6%]
Japan	100,213	95,966	-0.9%	15	15	0.0% [0.0%]	207.2	214.9	0.7% [-83.9%]	32,243	29,776	-1.6% [183.9%]
Other East Asian countries												
India	2,008	2,880	7.5%	15	15	0.0% [0.0%]	156.4	172.5	2.0% [27.2%]	856	1,113	5.4% [72.8%]
Australia	1,696	1,226	-6.3%	15	15	0.0% [0.0%]	151.8	155.2	0.4% [-6.8%]	745	526	-6.7% [106.8%]
New Zealand	423	314	-5.8%	15	15	0.0% [0.0%]	85.3	84.9	-0.1% [1.8%]	331	247	-5.7% [98.2%]

Notes: East Asia includes ASEAN+6 (except the Philippines) and Taiwan (16 countries/regions). Trade values are in constant US dollars deflated by the US import price index. The definition of "parts & components" is in accordance with RIETI-TID. The number of exported goods is counted at the finest level of the SITC.
Source: Author's calculation using the UN Comtrade (SITC Rev. 4).

tured parts with various trading partners along with the development of East Asian production networks. Since 2011, Japan's intra-East Asian exports of manufactured parts have fallen into negative growth; however, China, Korea, and Taiwan have continued to perform well, achieving high growth rates, such as the annual average rate of 10.5% in Taiwan. More than 90% of such high export growth in China, Korea and Taiwan is accounted for by the increase in the average export value per destination-product pair at the intensive margin, while the trade growth contribution of extensive margin is limited. Manufactured parts trade within the regional production networks appears to be expanding strongly as the pipes of the trade relationships of various manufactured parts between the various trading partners that China, Korea, and Taiwan have built through East Asian production networks are thickened.

Among the ASEAN countries, Malaysia is the largest exporter in the intra-East Asian manufactured parts trade, but even recently in 2016, its export value was less than half that

of the Northeast Asian countries. In addition to Malaysia, Thailand, Singapore, Vietnam and Indonesia export some manufactured parts to all the 15 East Asian countries. On the other hand, even as of 2016, there are some countries where Cambodia, Laos, Myanmar (hereafter CLM) and Brunei have not exported any manufactured parts. Also, from the perspective of the diversity of manufactured parts being exported, the average number of exported goods per destination country is reaching the level of the Northeast Asian countries only for Thailand and Singapore, followed by Malaysia. For CLM and Brunei, less than 10% of the items that exist statistically are exported on average per destination country. These facts suggest that there is great room for ASEAN countries to establish trading relationships of more manufactured prats with more trading partners through East Asian production networks.

For example, Vietnam's intra-East Asian exports of manufactured parts have achieved remarkable growth at an annual average rate of 36.9% in the period from 2011-2016, and are moving ahead of Indonesia and approaching the level of Singapore's export value. Most of this rapid export growth (85.7%) is accounted for by the sharp increase in the average export value per destination-product pair at the intensive margin. Meanwhile, the average number of exported goods per destination country has also risen at an annual average rate of 4.6%, and its contribution to the total export growth is non-negligible, standing at 14.3%. For intra-East Asian exports of manufactured parts by ASEAN countries, the rise of the average number of exported goods at the extensive margin is an essential driver of the trade growth compared to the Northeast Asian countries. Even for countries with low growth rates of the intra-East Asian manufactured parts exports, such as Indonesia and Malaysia, the average number of exported goods is steadily increasing, and the growth contribution of the diversification of exported goods at the extensive margin is as high as 65.8% and 37.9%, respectively. Furthermore, for CLM and Brunei, the number of destination countries, as well as the number of exported goods, has been steadily rising at the extensive margin.

In Table 4, the same decomposition analysis as in Table 3 is conducted for the growth of intra-regional manufactured parts exports by East Asian countries from 2001 to 2006, just 10 years ago. For comparison purposes, the exporting countries on the left column are in the same order as in Table 3. Note, however, that, Laos, Myanmar, and the Philippines are not included as "East Asia" due to data limitations, and the number of destinations per exporting country is up to 13. The average number of exported goods is up to 260 items, counted at the finest level of SITC Rev. 3 according to the RIETI-TID definition of "parts & components." Let us compare the contributions of extensive and intensive margins of intra-East Asian manufactured parts exports between Tables 3 and 4. For ASEAN countries, the diversification of destination countries and exported goods has contributed to a certain extent to the growth of intra-East Asian manufactured parts exports since 2011. Nevertheless, compared to the first half of the 2000s, the contribution of intensive margin has steadily increased overall.

Table 4. Extensive and intensive margins of intra-regional manufactured parts exports by East Asian countries: 2001-2006.

	Export value (million US dollars)			Changes at extensive margins: Number of destinations (max: 13)			Changes at extensive margins: Average number of exported goods per destination (max: 260)			Changes at intensive margin: Average export value per destination-product pair (thousand US dollars)		
	2001	2006	Annual average growth rate	2001	2006	Annual average growth [Contribution]	2001	2006	Annual average growth [Contribution]	2001	2006	Annual average growth [Contribution]
ASEAN countries												
Malaysia	22,580	25,669	2.6%	13	13	0.0% [0.0%]	167.4	189.4	2.5% [96.3%]	10,377	10,426	0.1% [3.7%]
Thailand	8,344	13,745	10.5%	13	13	0.0% [0.0%]	156.7	179.0	2.7% [26.7%]	4,096	5,907	7.6% [73.3%]
Singapore	13,061	21,760	10.7%	13	13	0.0% [0.0%]	209.7	215.4	0.5% [5.2%]	4,791	7,771	10.2% [94.8%]
Vietnam	594	1,587	21.7%	13	13	0.0% [0.0%]	57.0	90.2	9.6% [46.6%]	801	1,354	11.1% [53.4%]
Indonesia	2,346	5,586	19.0%	12	13	1.6% [9.2%]	108.2	137.0	4.8% [27.2%]	1,807	3,137	11.7% [63.5%]
Cambodia	2	1	-3.5%	11	10	-1.9% [53.8%]	5.9	6.4	1.6% [-45.0%]	26	22	-3.2% [91.3%]
Laos	..	..	..	..	..	..	..	..	..	..	..	..
Myanmar	..	..	..	..	..	..	..	..	..	..	..	..
Brunei	2	2	-0.4%	9	11	4.1% [-893%]	6.9	10.6	9.1% [-1933%]	29	15	-12.3% [2926%]
Northeast Asian countries												
Taiwan	22,210	53,110	19.0%	13	13	0.0% [0.0%]	199.3	210.4	1.1% [6.2%]	8,572	19,419	17.8% [93.8%]
China	16,649	50,288	24.7%	13	13	0.0% [0.0%]	206.4	229.8	2.2% [9.7%]	6,205	16,836	22.1% [90.3%]
Korea	16,285	50,934	25.6%	13	13	0.0% [0.0%]	190.2	199.6	1.0% [4.2%]	6,585	19,628	24.4% [95.8%]
Japan	57,547	81,593	7.2%	13	13	0.0% [0.0%]	224.5	229.3	0.4% [6.1%]	19,721	27,371	6.8% [93.9%]
Other East Asian countries												
India	857	1,122	5.5%	13	13	0.0% [0.0%]	125.9	153.0	4.0% [72.4%]	524	564	1.5% [27.6%]
Australia	1,082	1,457	6.1%	13	13	0.0% [0.0%]	170.4	175.2	0.6% [9.4%]	488	640	5.5% [90.6%]
New Zealand	253	372	8.0%	13	13	0.0% [0.0%]	82.5	87.7	1.2% [16.0%]	236	326	6.7% [84.0%]

Notes: East Asia includes ASEAN+6 (except Laos, Myanmar, and the Philippines) and Taiwan (14 countries/regions). Trade values are in constant US dollars deflated by the US import price index. The definition of "parts & components" is in accordance with RIETI-TID. The number of exported goods is counted at the finest level of the SITC.
Source: Author's calculation using the UN Comtrade (SITC Rev. 3).

IV. Examination of the diversification of exported goods and destinations

This section examines whether new trade relationships are still being established in East Asian production networks and whether the web of trade relationships is continuing to expand. If such a fact is to be confirmed, the pipes of trade relationships that have been built will gradually become thicker in the future, and the manufactured parts trade through regional production networks will be expected to continue strongly expanding. The next subsection first analyzes the diversity of exported goods and destination countries for intra-regional manufactured parts exports by respective East Asian countries. Section IV-2 focuses on recent developments in ASEAN countries and compares changes in the diversity of ex-

ported goods and destinations between ASEAN forerunner and latecomer countries.

IV-1. Diversity of exported goods and destinations in intra-East Asian manufactured parts exports

We will analyze the diversity of exported goods and destination countries in the East Asian intra-regional export of manufactured parts using the same approach as Obashi and Kimura (2017). Obashi and Kimura (2017) define manufacturing parts in the machinery industry at the most disaggregated six-digit level of the Harmonized Commodity Description and Coding System (HS), and they count the number of goods exported by respective East Asian countries to the neighboring partners, the number of export destination countries, and the combinations of exported goods and destinations. In the current section, using the same data set Obashi and Kimura (2018) introduced in the previous section, we count the number of manufactured parts exported, the number of destination countries, and their combinations by focusing on the SITC codes at the finest level that corresponds to the "parts & components" defined by the RIETI-TID. The more diverse the combinations of exported manufactured parts and destination countries, the more deeply the country of concern is integrated into the regional production networks. On the other hand, if the proportion of product-destination combinations actually being traded is limited, then there is much room left for new trade relationships to be established. We will consider the extent to which East Asian countries are integrated into the regional production networks and whether there exists room to further expand and deepen their participation in the networks.

Table 5 shows the number of "parts & components" exported by respective East Asian countries to any partner in the region, the number of destination countries where some parts are exported, the number of product-destination pairs that are actually traded, and the proportion of the actually traded product-destination pairs to the number of potential pairs, in 2001, 2006, 2011, and 2016. The exporting countries listed in the leftmost column are grouped into ASEAN countries, Northeast Asian countries, and other East Asian countries, and they are in descending order by the intra-East Asian "parts & components" exports in 2016, as in Tables 3 and 4. Also, due to data limitations, Laos, Myanmar, and the Philippines are not included in "East Asia," and the number of destinations for each exporting country is limited up to 13 countries. The number of exported goods is limited up to 260 items. The number of potential product-destination pairs varies across exporting countries as well as by year and is calculated as the product of the number of exported goods and the number of destinations at the aggregate, regional level for each exporting country. This calculation is considered to approximate the number of potential trade relationships.

China, Japan, Korea, and Taiwan export nearly all of the 260 items in the statistically existing manufactured parts from 2001 to 2016 to one or more partner countries in East Asia. At the same time, these countries export some manufactured parts to all of the 13 neighboring partner countries. Furthermore, among the potential trade relationships calculated as a product of exported goods and destination countries at the regional level, the pro-

Table 5. Number of exported goods and destinations in the intra-regional manufactured parts exports by East Asian countries.

	Number of exported goods (max: 260)				Number of destinations (max: 13)				Number of product-destination pairs traded				The proportion to the possible product-destination pairs			
Year	2001	2006	2011	2016	2001	2006	2011	2016	2001	2006	2011	2016	2001	2006	2011	2016
ASEAN countries																
Malaysia	256	258	258	258	13	13	13	13	2,176	2,462	2,514	2,544	65.4%	73.4%	75.0%	75.8%
Thailand	257	256	255	256	13	13	13	13	2,037	2,327	2,449	2,568	61.0%	69.9%	73.9%	77.2%
Singapore	259	259	260	260	13	13	13	13	2,726	2,800	2,731	2,654	81.0%	83.2%	80.8%	78.5%
Vietnam	193	231	243	249	13	13	13	13	741	1,172	1,695	1,984	29.5%	39.0%	53.7%	61.3%
Indonesia	241	253	258	257	12	13	13	13	1,298	1,781	2,022	2,080	44.9%	54.2%	60.3%	62.3%
Cambodia	48	47	91	123	11	10	11	12	65	64	146	279	12.3%	13.6%	14.6%	18.9%
Brunei	48	80	104	118	9	11	11	12	62	117	181	218	14.4%	13.3%	15.8%	15.4%
Northeast Asian countries																
Taiwan	260	259	260	260	13	13	13	13	2,591	2,735	2,760	2,794	76.7%	81.2%	81.7%	82.7%
China	259	259	260	260	13	13	13	13	2,683	2,987	3,119	3,181	79.7%	88.7%	92.3%	94.1%
Korea	259	257	260	259	13	13	13	13	2,473	2,595	2,731	2,761	73.4%	77.7%	80.8%	82.0%
Japan	260	259	260	260	13	13	13	13	2,918	2,981	2,978	3,036	86.3%	88.5%	88.1%	89.8%
Other East Asian countries																
India	251	248	257	257	13	13	13	13	1,637	1,989	2,241	2,424	50.2%	61.7%	67.1%	72.6%
Australia	259	257	258	258	13	13	13	13	2,215	2,278	2,254	2,248	65.8%	68.2%	67.2%	67.0%
New Zealand	246	242	247	247	13	13	13	13	1,072	1,140	1,275	1,265	33.5%	36.2%	39.7%	39.4%

Note: See the notes of Tables 3 and 4.
Source: Author's calculation using the UN Comtrade (SITC Rev. 3 for 2001 and 2006; SITC Rev. 4 for 2011 and 2016).

portion of trade relationships being active is steadily rising, and the figures rise to 80% to 90% as of 2016. In China, 94.1% of the potential trade relationships are actually active. These facts suggest that complex international production networks have been established in East Asia, centering on China and other Northeast Asian countries.

Malaysia, Thailand, and Singapore, similar to China, Japan, Korea, and Taiwan, export nearly all of the 260 items to any partner in East Asia and export some manufactured parts to all of the 13 neighboring partners. At the same time, the proportion of active trade relationships has steadily risen to reach 80% during the period from 2001-2016. New trade relationships have been established exporting manufactured parts that have been already exported to some neighboring partners, in order to serve a new country market. It appears that Malaysia, Thailand, and Singapore are "deepening" their participation in East Asian production networks in the sense that they have started exporting existing exported goods to new destination countries. In addition, the number of active product-destination pairs has decreased slightly in Singapore between 2011-2016. It appears that the expansion of Singapore's participation in East Asian production networks has plateaued in terms of the diversity of trade relationships, but it is also possible that production networks involving Singapore are simply becoming more efficient through selection and concentration. A similar levelling-off trend has been observed for Australia and New Zealand, and further analysis of this trend is anticipated.

Vietnam and Indonesia have been "widening" their participation in East Asian production networks, in the sense that they have increased the number of items of manufactured parts exported to any neighboring partner in 2001-2016. On the other hand, the proportion

of active transactions to the potential trade relationships has risen significantly between 2001 and 2016, from 29.5% to 61.3% for Vietnam and from 44.9% to 62.3% for Indonesia. There is still much room left for these countries to "deepen" their participation in East Asian production networks by diversifying the export destinations of the existing exported manufactured parts. Such extra room for "deepening" the participation in the production networks is also observed for India.

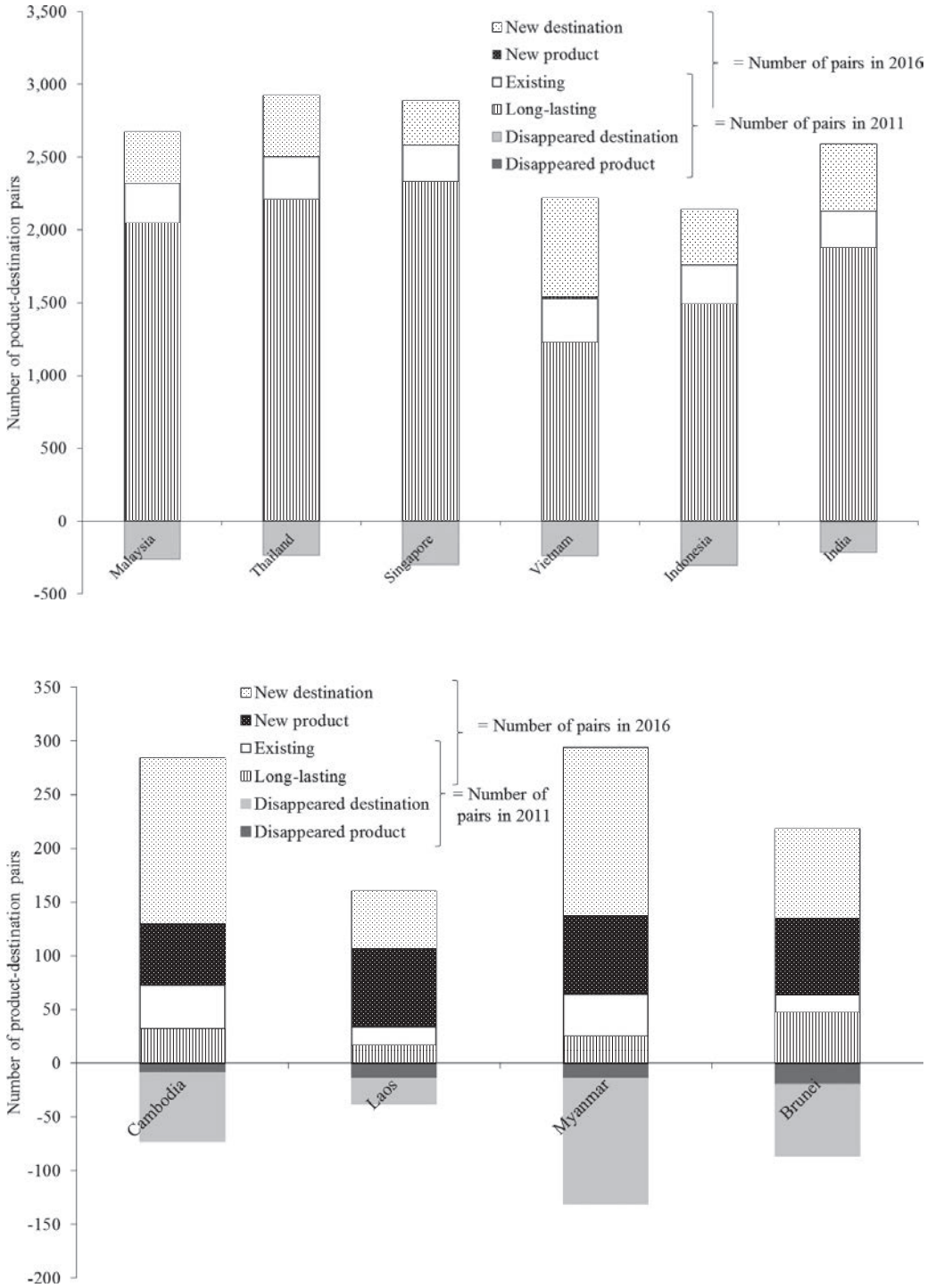
As for Cambodia and Brunei, although the number of items of manufactured parts exported to some neighboring partner has doubled from 2001 to 2016, it does not reach half of the statistically possible maximum number. Compared with ASEAN forerunners, the degree to which Cambodia and Brunei have been integrated into East Asian production networks is very limited. Furthermore, the proportion of active trade relationships for Cambodia and Brunei is less than 20%, even in 2016. Notably, in the case of Cambodia and Brunei, not only has the number of exported goods doubled, but the number of export destinations in East Asia has also steadily increased; therefore, the number of potential product-destination pairs has been rapidly increasing year by year. Due of this, even if the number of active trade relationships is increasing, the proportion to potential combinations is likely to be underestimated. Even with such data characteristics in mind, Cambodia and Brunei clearly have been left behind in the development of regional production networks spread around East Asia.

IV-2. Diversification of exported goods and destinations in ASEAN countries since 2011

Next, by looking into the diversification of exported goods and destination countries in ASEAN countries, we will consider how the ASEAN latecomers such as CLM and Brunei are being incorporated into the international production networks in the East Asia region and to what extent the ASEAN forerunners have deepened their participation in the production networks. Specifically, we will sort by type how the combination of exported goods and destinations of the intra-East Asian exports of manufactured parts by ASEAN countries has changed from 2011 to 2016. Focusing on the latest period from 2011-2016 enables us to analyze not only Cambodia and Brunei, but also Laos and Myanmar. Specifically, we can examine the extent to which these countries have participated in the East Asian production networks. India is also included in the analysis as a comparison target for ASEAN countries.

Figure 4 shows stacked bar charts colored by type of change from 2011 to 2016, plotting the number of pairs of exported goods and destinations on the vertical axis, for intra-East Asian "parts & components" exports by ASEAN countries and India. We call the pairs of exported goods and destinations that are traded at two points in 2011 and 2016 as "existing" pairs. Among them, the product-destination pairs traded continuously from 2011 to 2016 are considered as "long-lasting" pairs. The product-destination pairs whose product was not exported to any country within the East Asian region as of 2011 but starts to be exported to one or more countries in the region by 2016 are called "new product" pairs. In the case

Figure 4. Changes of the product-destination pairs in the intra-East Asian manufactured parts exports by ASEAN countries and India: 2011-2016.



Note: See the notes of Table 3.
Source: Author's calculation using the UN Comtrade (SITC Rev. 4).

where the product of concern was exported to one or more countries in East Asia as of 2011, if the product starts to be exported to the other countries by 2016, the corresponding product-destination pairs are called "(existing product and) new destination" pairs. In addition, there exist some product-destination pairs that were traded as of 2011 but disappeared before 2016. Among such disappeared pairs, if the product of concern is no longer exported to any country in East Asia in 2016, the corresponding product-destination pairs are called "disappeared product" pairs; if the product continues to be exported to at least one country in East Asia in 2016, the product-destination pairs are called "disappeared destination" pairs. Notice that the "long-lasting" pairs are a subset of the "existing" pairs. With this in mind, the total number of the "existing," "disappeared product," and "disappeared destination" pairs is equal to the number of the product-destination pairs being traded as of 2011, and the total number of "existing," "new product," and "new destination" pairs is equal to the number of pairs traded as of 2016.

It is obvious that in Malaysia, Thailand, Singapore, Vietnam, Indonesia and India, the majority is the "existing" pairs that are traded in both 2011 and 2016. In terms of the proportion to the number of product-destination pairs being traded as of 2011, nearly 90% are "existing" pairs, and 80 to 90% of them are "long-lasting" pairs that are continuously traded throughout 2011-2016. For the ASEAN forerunners and India, once trade relationships are established, they are usually traded without interruption, and the relative importance of such long-lasting transactions appears to be increasing year by year, which complements the fact observed in Section III-3 that the contribution of the intensive margin to the growth of intra-East Asian manufactured parts exports has risen.

Despite the dominance of the long-lasting trade relationships, the formation of "new destination" pairs and the loss of "disappeared destination" pairs take place at a non-negligible rate from 2011 to 2016. Starting to export the existing products to new destination countries and simultaneously switching destination countries can be regarded as indicating that the international production networks are being reorganized. Focusing on the net change of "new destination" pairs minus "disappeared destination" pairs, we can observe that Vietnam and India are deepening their participation in the production networks by diversifying destinations for the existing manufactured parts. As can be seen from Table 5 in the previous subsection as well, the ASEAN forerunners and India have already exported almost all items existing in statistics as of 2011 to any partner country in East Asia; there are almost no "new product" pairs that are newly exported in 2016 or "disappeared product" pairs that are no longer exported in 2016.

In contrast to the recent developments in the ASEAN forerunners and India, CLM and Brunei have a limited presence of "existing" pairs that are traded in both 2011 and 2016. The proportion of "existing" pairs to the number of product-destination pairs being traded as of 2011 is only 30 to 50%, less than half of which is accounted for by the "long-lasting" pairs. For the ASEAN latecomers, there are many cases where the trade relationship has been disrupted in just five years once established, and the relative importance of the long-lasting trade relationships is still low. While seeming to be left behind in the develop-

ment of the international production networks that spread across the East Asian region, it is also a fact that CLM has as many "new product" pairs as as "existing" pairs. This indicates that CLM is actively participating in the East Asian production networks by starting to export new manufactured parts. In addition, "new destination" pairs are born one after another, although there are many "disappeared destination" pairs as well. The net increase of "new destination" pairs is especially large in Cambodia, which appears to be getting integrated into the East Asian production networks by diversifying destinations of the existing manufactured parts.

V. Conclusion

In this paper, we have clarified the reality of the expansion and deepening of international production networks in the East Asia region by carefully analyzing the bilateral trade statistics at the product level. In East Asia, the trade of manufactured parts occurring within production networks of the machinery industry, among others, has been dramatically expanding over the past few decades. The manufactured parts trade through East Asian production networks continues to grow steadily, even though the global merchandise trade has remained nearly flat since 2011, recovering from the Great Trade Collapse. In particular, the East Asian intra-regional trade of electric machinery parts and components has strongly recovered. Although changes have been observed that suggest the domestic supply capacity of electric machinery parts is increasing in China, the fact that China's import demand for electric machinery parts from East Asian neighboring partners has declined is not detected. At least the expansion of manufactured parts trade through the East Asian production networks of the electric machinery industry has not plateaued.

The robustness of the manufactured parts trade through East Asian production networks is underpinned by the increase in the amount of trade in the existing trade relationships. Led by China, Japan, Korea, and Taiwan, trade relationships with various trading partners and involving various manufactured parts have been built through the East Asian production networks, and their pipes have become thicker, leading to a solid increase in East Asian intra-regional trade of manufactured parts. Nevertheless, there still remains room for ASEAN countries to expand and deepen their participation in East Asian production networks and to establish trading relationships with more trading partners for more manufactured parts. Indeed, Malaysia, Thailand, and Singapore have deepened their participation in production networks by starting to export existing manufactured parts to new destinations in the East Asian region. In the meantime, for the ASEAN forerunners, existing trade relationships are usually traded continuously without interruption, and the relative importance of such long-lasting trade relationships is increasing year by year. It is expected that the pipes of the trade relationships that have just been built will gradually become thicker, and manufactured parts trade through the East Asian production networks will continue to grow strongly in the future. Indonesia and Vietnam, the latter of which is catching up rapidly, are diversifying exported manufactured parts and expanding participation in the East Asian production net-

works, but there is much room to deepen their participation in the production networks by further diversifying export destinations.

Cambodia, Laos, Myanmar and Brunei have been left behind in the development of international production networks spread across East Asia. However, it seems that the ASEAN latecomers are being incorporated into East Asian production networks by starting to export new manufactured parts and increasing the number of export destinations. It is still an important policy issue to establish what kind of trade policy and development strategy, including investment policy, should be made in order to extend the benefits of the East Asian production networks to support the economic development of ASEAN latecomers.

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