



The Triangular Trade Structure of the East Asian Production Network

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Abstract

This paper focuses on vertical specialization and the triangular trade structure in East Asian production network. First, we introduce the structure of Asian international input-output table and show how to decompose gross exports by using the input-output tables. The empirical results indicate that Chinese share of value-added exports in gross exports have been decreasing but that of Asian value-added increasing not only in China but also in the other countries. The share of domestic value-added for the manufacturing sector reveals that China has moved downstream in the regional production networks. In other words, China has been depending more on its upstream economies like Japan and South Korea. Similarly, the analysis of value-added exports shows that a large portion of value-added export in South Korea comes from Japan. Furthermore, Japan is a major supplier of value-added in regional production network especially in service and manufacturing sectors.

JEL Classification: F1, F15, F19.

Keywords: Vertical Specialization; Value-added exports; International Input-Output Table; East Asian Economies.



Introduction

This paper studies the methodology of measuring the precise amount of trade and empirical investigation of trade patterns among three East Asian countries under the case of vertical specialization. So far, a great number of literatures have paid attention to the vertical specialization and developed the right measurement of it. Based on the substantially large degree of vertical specialization, we try to answer the question of what is the pattern of trade among East Asian countries. This paper contributes to the literature by developing a methodology of measuring vertical specialization among three countries and by suggesting trade policy implications from the empirical result. In particular, China and South Korea trade intermediate goods dominantly and they have high dependency of parts and basic materials on Japan. These are sufficient conditions for them to diversify their trading partners in the long run.

The U.S. Census Bureau has reported the fact that gross export of goods only was \$1,579 billion and gross imports was \$2,268 billion in 2013. We can obtain a decomposition of this trade balance by all the trading partners. In 2013, the U.S. has the highest total trade (\$632 billion) with Canada but the most trade deficit (\$318 billion) with China.

Why does the trade balance from each country based on the gross value matter? It is not accurate because of double counting in each gross value. Today, the international trade relationships among global economy get even more complicated as the level of interdependence of all countries gets higher. Especially, the economic relationship between the U.S. and the East Asian countries are getting closer especially in manufacturing sectors. However, the trade balance data cannot capture the cases, relating the role of third countries in bilateral trade. Only value-added trade data can uncover those cases even though data availability is very limited. It is recent for the OECD and the WTO to undertake this joint work of value-added trade data. In the OECD-WTO database, the domestic value-added and intermediate imports were already taken care of to measure the U.S. Bilateral trade balances.



The U.S. trade deficit in terms of the value-added was smaller in China, NAFTA partners, and Italy but larger in Germany, Japan, South Korea and other EU countries. We can explain these differences between gross and value-added trade as follows. The gross exports consist of three elements: domestic value-added that remains in foreign countries; domestic value-added that returns home; and foreign value-added in the exports. In the same manner, the gross imports also consist of three elements: the foreign value-added stays in the country; the foreign value-added in imports, which export again later; and domestic value-added in its imports. However, a value-added export only counts the domestic value-added that remains in the foreign country and value-added imports do the foreign value-added that stays in the foreign country.

Theoretically, a countries trade balance should be the same in terms of gross or value-added terms because domestic and foreign value-added over all the countries cancel each other out over a total trade. However, bilateral trade balances can be different dramatically. Differences between gross and value-added bilateral trade give us important lessons for not only theoretical perspectives but also the implication perspectives of trade policy.

The contribution of this paper is actual calculation of all the vertical specialization measures using the method of decomposition among value-added exports, domestic content and foreign content. The data comes from the existing Asian International Input-Output Tables for China, Japan, and South Korea during 1995, 2000, 2005. We also suggest industry and trade policies based on the empirical results for each country.

We organize this paper as follows: Section 2 introduces related literatures. Section 3 introduces the data, the methods of analyzing vertical specialization and shows the results and their implication. Section 4 concludes.

Related Literature

There has been abundant literature to explain how vertical specialization can be measured. Feenstra (1998) introduces three different methods of measuring the vertical



specialization. First of all, Hanson et al. (2005) use the firm level survey data. However, the data sets are limited in terms of the number of countries, which are the U.S. and Japan. They have been focusing on intermediate inputs in multinational enterprises. Second, Athukorala and Yamashita (2006) have measured vertical specialization by using the data from most countries in the world in the five-digit Standard International Trade Classification (SITC) Rev 3. They consider that certain goods, such as machinery and transport equipment and miscellaneous manufactured articles as intermediate inputs. They find that trade volume in intermediate inputs increased from 18.5% to 22% relative to manufacturing exports from 1992 to 2003. However, they cannot develop either the measure of vertical specialization or that of the value-added trade. Third, the method of using input-output tables is the most traditional and popular in this literature. Hummels et al. (2001), Yi (2003), Daudin et al. (2011), and Koopman et al. (2012) are extensive among the papers adopting this method.

Hummels et al. (2001) have used input-output tables for 14 countries and calculated the degree of vertical specialization, by introducing the share of imported intermediate goods in gross exports. They call this measure as VS for vertical specialization. They found that the share of VS relative to gross exports increased from 18% in 1970 to 23.6% in 1990. Yi (2003) presents more detailed results by extending Hummels et al. (1998) and Hummels et al. (2001) even though it is limited to the case of the U.S.

More recently, a growing literature, including such as Daudin et al. (2011) and Johnson and Noguera (2012), use International Input-Output tables based on World Input-Output database (WIOD) and the Global Trade Analysis Project (GTAP). In order to estimate value-added trade, they consider the pros and cons of the relationship between their works with Hummels et al. (2001) but they are more closely related to the Heckscher-Ohlin-Vanek model, which is the factor content trade literature. Koopman et al. (2012), by the way, integrate the literature on trade in value-added and vertical specialization.

Daudin et al. (2011) use the similar method to Yi (2003), but they compute VS, the measure of vertical specialization for all the countries in three years: 1997, 2001, and 2004. Moreover, they can also compute VS1, another measure of vertical specialization because the worldwide international input-output tables is available for the calculation.



Similarly, Johnson and Noguera (2012) customize the GTAP data for only 2004 with 87 regions and analyze the example of China and Mexico to take into account the comparison between the gross exports and the value-added exports. In 2004, they found that the share of value-added exports in China and Mexico was 59% and 52% correspondingly.

Koopman et al. (2014) break up gross exports into not only various value-added terms but also additional terms which is double counted. Their mathematical calculation of value-added terms makes a good connection with gross export terms. In addition, they compare all the measures of vertical specialization and value-added trade in the previous literature with their unified framework.

Analysis of Vertical Specialization

In order to analyze the technological structure of gross exports, we use an input-output analysis method. First, gross exports are decomposed into several elements, with a focus on the relations among gross exports; value-added exports, domestic content of exports, and foreign content of exports. Then, we measure each category of exports, with reference to the above four export measures. Finally, by using the previous measurements, we drive the indices of vertical specialization in this section.

Gross exports can be disintegrated as value-added exports, re-imports, and foreign content. The foreign content represents value-added that is generated outside the exporting country. So, the foreign content should be excluded from export values to measure the production technology of each country. In this regard, value-added exports should be included in the measure, because it represents the value-added incorporated in the exports and indirectly exported to the other countries. However, the re-imports are sometimes complicated because they are the value-added content that is exported once but returned and finally absorbed in the country. Therefore, the value-added content from the re-import is not actually exported but it is still belonging to a part of the domestic content. In other words, the domestic content of exports contains both the



value-added exports and the re-imports. In addition, we need to introduce the indices of vertical specialization to demonstrate how each country is engaged in regional production network.

The purpose of our study is to calculate all the measures using value-added exports, domestic content, and foreign content for China, Japan, and South Korea from the existing International Input-Output Tables (1995, 2000, and 2005.) We also suggest policy for industry and trade for the three countries.

There are several measurements discussed in this study. Originally, Hummels et al. (2001) and Daudin et al. (2011) introduced two measurements of vertical specialization, which are VS and VS1. The VS represents the foreign content proportion and the VS1 does the re-import proportion of gross exports. In this section, we are going to discuss a three-country model with only one sector to calculate the measurements and we compare the components of our three-country decomposition formula with the existing other measures in the literature. Finally, we analyze the general Asian triangular trade structure.

Suppose a three-country and one-sector world, where all the countries produce only in a single sector that is tradable. We can categorize this gross product as follows: direct consumption, intermediate inputs, and an export, which includes both intermediate and final goods. Koopman et al. (2012) shows the two country cases for an example and expand to the general cases but we need three country cases for the triangular trade in East Asia.

Data

In order to analyze the vertical specialization accurately, we need the International Input-Output Table between related countries. The International Input-Output (hereafter, I-O) Table is a statistical table used for analyzing the production, the distribution, and the inter-country trade between several countries. The table is constructed by integrating the I-O tables of different countries with their trade statistics. We can compare the international industrial structure under the unified industry classification



and further the inter-country commodity trade, the demand structure, and the interdependence in the International I-O Table.

The Institute of Developing Economies-Japan External Trade Organization (IDE-JETRO) produced the international I-O Table for 1985, 1990, and 1995 in cooperation with institutions from China, Japan, South Korea, U.S., and southeastern countries of Indonesia, Malaysia, Philippines, Singapore, Taiwan, and Thailand. This Asian International Input-Output Table focuses on the Asia-Pacific region for its country coverage. The International I-O Table has the same structure as the original domestic Input-Output Table. It divides both exports and imports into intermediate and final goods. The former represents the endogenous part and the latter the exogenous one.

Based on the 2000 International I-O Table, we selected such countries as Taiwan, Indonesia, Malaysia, Philippines, Singapore, Thailand, and U.S. and then classified them as Rest of the World (hereafter, ROW.) Thus, there are three countries left, China, Japan, and South Korea.

Sectors are classified as follows: 78 sectors are integrated into 23-sectors and then 23-sectors into 10-sectors, and finally 10 sectors into 5-sectors. The import and the export by each product is connected with 23-sector classification of the international I-O table by matching 100 products on the basis of HS 2-digit of the import and export by product in the Trade Statistics Information Service ([http:// stat.kita.net](http://stat.kita.net)) in the Korean Trade Association ([http:// www.kita.net](http://www.kita.net).)

Results

Trade Structure for Three Countries

The share of domestic content of exports (hereafter DC share) and the ratio of value-added exports to gross exports, (hereafter VAX ratio) for South Korea are shown as follows. The DC share has been almost constant from 97.6% in 1995 to 97.5% in 2000 and 97.6% in 2005, respectively, on an average of total industries. It implies a successful localization of basic raw materials in the manufacturing sector which has been pursued so far. In terms of specific sectors, the DC share of industrial products in



2005 is 78.5%, of which consumption goods has the highest of 87.3%, and was followed by the assembly and processing (79.8%) and the basic raw materials (73.9%.)

On the other hand, the VAX ratio, on average for all the sectors, has decreased from 96.5% in 1995 to 96.1% in 2000 to 96.0% in 2005. Specifically, the VAX ratio for industrial products in 2005 was 62.1%, and for consumption goods it was the highest at 74.1%. For assembly and processing, it was 60.5% and for basic raw material, it was the lowest at 55.8%. As the Korean economy has a relatively high dependency on foreign economies by the measure of vertical specialization. Moreover, it has been increasing so we can tell Korean economy is very sensitive to any change from outside.

For China, in the 1995 I-O table we cannot distinguish export from import in the final demand, meaning that the net export is seen in the table, and thus cannot calculate the domestic product ratio of 1995. Also, there are only 17 product sectors in 2000 and 2005 I-O table, which is different from the 23 classifications for South Korea and Japan. Thus we have to measure a rough domestic content by ten classifications.

The DC share for all industries fell to 96.6% in 2005 from 97.3% in 2000. This is because the input proportion of intermediary goods has been increasing sharply following rapid economic growth. In addition it leads to an increase in the trade size. The DC share of manufacturing products in 2005 was 86.9%, that of consumption goods was highest at 93.5%, followed by basic raw materials (88.8%.) and assembly and processing (79.0%.) The low share for assembly and processing is explained by the rapid increase in the re-exporting of commodities produced from the assembly of electric and electronic products.

The VAX ratio for all industries fell to 94.5% in 2005 from 95.5% in 2000. The ratio of manufacturing products in 2005 was 71.7%, and that for consumption goods was highest at 82.2%. But assembly and processing was lowest at 63.2%, down from 74.2% in 2000. The sharp decrease is due to enforcement of a sort of processing trade structure. This means that multi-national enterprises in China imports intermediary goods such as raw materials and parts, and then assembles them because of low labor cost. This may cause the Chinese economy sensitive to external changes like economic fluctuations from trading partners' economy.



The DC share for Japan has fallen for all sectors to 94.7% in 2005 from 96.1% in 2000. This is because input proportion of intermediary increased due to a sharp rise in international raw material prices during this time period. The share of manufacturing products in 2005 was 87.6%, of which consumption goods was highest at 93.1% followed by assembly and processing (88.4%) and basic raw materials (83.5%.)

For all industries, the VAX ratio fell from 93.4% in 2000 to 90.7% in 2005 on average. The VAX ratio for manufacturing products in 2005 was the highest at 78.5%. The consumption goods were 86.6% in 2005 followed by assembly and processing (77.2%) and basic raw materials (73.1%.)

The Vertical Specialization among Three Countries

Vertical specialization consists of two crucial parts, which are an import and an export part. On the import side, it includes intermediate goods that are used to make final goods for export. On the export side, it can include both final goods and intermediate goods. We are going to use two vertical specialization measures, called VS and VS1, because they are most intuitive and consistent with the previous measures. VS, which is called the foreign content of gross exports, measures the imported input content of export goods. VS1 measures the value of domestic Content in intermediate exports that finally return home. These accounts involving two measures can be the main culprit of double counting in trade statistics because these cross national borders at least two times.

We discuss the vertical specialization share to the gross exports among three countries, China, Japan, and South Korea. We decompose each VS and VS1 account by each country. In addition, we measure the VAX ratio of each country for other two trading partners again in order to analyze the trading structure among three countries only.

For Korea, the VAX ratio for all industry sectors in 2005 was 77.7%. It has increased infinitesimally relative to 77.6% in the year 2000. We believe this is due to the stability of the exchange rate, and a slight increase in local parts and materials. An annual exchange rate of the Korean Won to the US dollar was 771.04 Won per Dollar in 1995.



It had been 1,130.61 Korean Won in 1998 from foreign currency crisis, but decreased to 1,024.31 in 2005. In the same period, the VS share of the ROW, Japan and China has increased by 22.3%, 4.6% and 2.4% respectively. The VS share of China and Japan has increased by more than that in 2000.

The VAX ratio for each good have the following descending ranking: mining, service industry, agriculture, forestry and fishing, and the manufactured good. The VAX ratio for consumption goods was the highest in the manufacturing sector in 2005 (75.9%), followed by assembly and processing (64.6%) and basic raw materials (54.4%). Especially, since South Korea has imported a lot of primary resources from oil-producing countries, the flowing-out to ROW has been increased by the petroleum and coal products and the chemicals and allied products.

For the manufacturing sector, the VS share to China increased by 4.2% point in 2005, while the inflow from China increased by 2.3% point. For most products, in most industries, the VS share is higher than the the VS1 share. Especially, VS share in textile products and leather products, primary metal fabricated products, furniture, miscellaneous manufacturing, electric, electronic products, and nonmetallic mineral products, seems to be higher, by 8.0%, 6.4%, 5.3%, 4.2%, 4.0%, respectively. In assembly and processing, the localization rate in Korean raw material and parts industry in 2000 was faster than that of China.

Korean trade surplus to China, are chemicals, transportation equipment, general machinery and equipment and so on. Sectors with trade deficit between them are textile products and leather products, food, beverage and tobacco, and nonmetallic mineral products. Although South Korea has the surplus in trade balances in many products, the VS share is bigger than the VS1 share. It is because a production inducement coefficient is bigger, for all VAX ratio in the manufacturing industry are less than Korean ones. 79.3% of products of South Korea to China export in the shape of intermediaries, 20.7% of those as final goods. 67.9% of goods imports as intermediaries and 32.1% imports as final goods. It implies an intermediary-oriented trade pattern between South Korea and China.



For Japan, the VS share in 2005 was 7.9% and the VS1 share was 0.5% on average in the manufacturing sector. As for a product, the value-added export is higher than the value-added import in most industries. Especially, ratios of the value-added export in chemicals, electric and other electronic products, transportation equipment, and primary metal and fabricated products are relatively big, but very low for the value-added import of that.

The sectors with the trade surplus from South Korea to Japan are food, beverage and tobacco, textile products and leather products, petroleum and coal products, etc. Products showing the trade deficit between them are mostly in relation to heavy chemical industries, for example, electric and other electronic products, chemicals and allied products, and so on. As a result, volume of flowing out the value-added has been increased. South Korea has the deficit in trade balances in most products to the Japan in many products and also the value added ratio and the production inducement coefficient is less than the Japan. It makes the VS share bigger than the VS1 share.

On the contrary, 41.6% of Korean exports to Japan is the intermediaries, 58.4% of those as final goods. 78.9% of imports are intermediaries and 21.1% imports are final goods. It says that South Korea exports mainly electric and other electronic products, primary metal and fabricated products of intermediary products to Japan but the exporting proportions of the same kind of those products by Japan to South Korea is only 36.1%. Japan exports chemicals and allied products, general machinery and equipment, and so on to South Korea. In case of final goods, South Korea has exported mostly consumption goods like the apparel; on the other hand, Japan has exported capital goods, for example, machinery and electric and other electronic products. High dependency of both parts and basic materials on Japan says that, the more South Korea exports a final good to the other countries, the more the value-added for Japan.

For China, the VAX ratio in 2005, on an average of all industries, is 80.6%. Those are 86.2% in 1995 and 84.1% in 2000. It shows the continuous decrease in the domestic value-added of trade activities among three countries. The VS for ROW was 15.0% from the natural resources like the petroleum. Also, the VS for South Korea was 2.0%



and that of Japan was 2.4%. It is due to a low VAX ratio despite a technical progress and a localization of the raw material and parts. The ratios for each good have the following descending rankings in 2005: agriculture, forestry and fishing 90.7%, service industry 88.2%, mining 84.1%, utilities and construction 81.0%, manufactured good 73.7%. The ratio of the consumption goods is the highest of products in the manufacturing sector in 2005 (80.5%) and was followed by basic raw materials (74.1%) and assembly and processing (68.9%).

In the meantime, China export the foreign content to Japan by 3.1% and re-import intermediate goods from Japan by 2.9%. With regard to goods, VS in the electric and other electronic products (4.1%), transportation equipments (3.7%), precision instruments (3.6%), and general machinery and equipment (3.5%) is relatively high. There are big VS1 in textile products and leather products (19.5%), furniture and miscellaneous manufacturing (6.5%), primary metal and fabricated products (3.0%), and electric and other electronic products (2.4%).

The sectors with trade surplus for China from Japan are food, beverage and tobacco, textile products and leather products, furniture and miscellaneous manufacturing, electric and other electronic products. Sectors with deficit for China are transportation equipments, chemicals and allied products, general machinery and equipment. These results are from the following reason. China exported mainly final goods to Japan, as well as imported intermediate one from Japan. As a result, China has trade deficit to Japan for some of intermediate and final products. Especially, there are a huge amount of the deficit in intermediate products of assembly and processing industry and final goods of in machinery sector. It implies that China imports intermediate products and produces final goods with them, and then re-exports them to Japan partly. Also the rest of them are met by the domestic demand and, at the same time, has been exported to other countries.



Conclusion

This study has analyzed the structure of industry and the trade patterns of three East Asian countries, which are China, Japan and South Korea, using the measures of vertical specialization, which are VAX, DC, VS, and VS1 through 1995, 2000, and 2005 Asian I-O Table released by IDE-JETRO.

The following two findings emerge from empirical results. First, all the vertical specialization measurements of Korean manufacturing sector imply the high dependency on the raw materials, i.e., natural resources South Korea does not have. The Chinese high DC share of manufacturing sector relative to the slightly low VAX ratio means that multinational enterprises in China import the intermediaries from their homeland, then take an advantage of low labor cost, and thus enforces the processing trade structures. As a result, the Chinese economy is sensitive to economic fluctuation of trading counterparts. Second, the VAX ratio of each country and the decomposition of the VS share by trading partners shows the fact that the Japanese VAX ratio was even higher than those in China and South Korea implies that Japanese economy was relatively self-dependent.

Based on empirical results, we can find the following implications. First, it is ambiguous to tell which country has more benefits from trade between China and South Korea. Although China had the trade deficit in the trade of industrial products to South Korea, the ratio of the value-added and the Chinese production inducement coefficient was bigger than those of South Korea. Second, it is necessary for China to diversify the trading counterparts in the long run because most products of Chinese exports, composed with intermediate goods from Japan. Third, South Korea has to raise the VAX ratio of those industries imminently to decrease high dependency of parts and basic materials on Japan. The more South Korea exports a final good to the other countries, the more the value-added exports of Japan.



These three countries have been pursuing the complementary or competitive relationship since 1990s through a continuous expansion of the trade and the investment one another. It is being in progress toward the horizontal division structure from the vertical structure. South Korea exports the raw material and the intermediate goods to China, and China does the consumption products to Japan. On the other hand, Japan exports the capital goods, core parts, and raw materials to both South Korea and China. It is not expected to change right away but they are expected to compete against one another to increase their own exports afterwards. However, these situations is likely to be effected by the policy change of each government, such as abolition of the preferential rate for the corporate income tax, decrease in an export tax rebate rate, meaning a sort of value-added tax rebate rate decrease, cutting an application for processing and assembly trade, expansion of imposing export tariff on commodities, and so on. These policies in China already make foreign companies leave China.

In sum, all of the measures of vertical specialization suggest that both South Korea and China should lower the dependence on Japan in the long run to strengthen their economies. They can achieve this goal to reinforce the following three industries, which are material industry, parts industry, and high-end technology industry. Furthermore, they can establish a self-dependent industrial system from the continuous diversification of the trade counterparts, the expansion of the domestic demand as well as productivity improvement.



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