CHAPTER 4

# Changes in the Trade Structure of the Metal Products Industry in East Asia from the Perspective of the International Division of Labor

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## 1 Introduction

Global warming, resulting from the emission of large amounts of carbon dioxide and other greenhouse gases into the atmosphere due to increased production activities and changes in lifestyles, is causing "climate change," which will significantly alter not only the temperature but also the climate of the entire planet. Since the Industrial Revolution, the global average temperature has already risen by 1.1 °C. From 2015 to 2019, the global average temperature was 0.2 °C higher than it was from 2011 to 2015, making this period the hottest five years since records were first kept. This situation is expected to continue at the current trajectory. If climate change continues at the current rate, huge economic losses are expected due to abnormal weather conditions and adverse effects on fisheries and

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agriculture caused by rising sea levels. Reducing the emission of carbon dioxide, the greenhouse gas with the greatest impact on global warming, has become one of the most urgent issues in the fight against climate change, and efforts are being made to reduce emissions through production activities. The industrial sector is the largest contributor to carbon dioxide emissions from production activities, with the steel industry accounting for a large proportion of these emissions. However, the iron and steel industry is a key industry at the national level, and the production scale, technological level, and policy formulation strategy vary from country to country; therefore, the carbon dioxide reduction targets of the iron and steel industry will not be easy to achieve.

The signing ceremony for the Regional Comprehensive Economic Partnership (RCEP) agreement was held on November 15, 2020, after 15 countries, mainly from East Asia, including Japan, China, and the ROK, agreed to a summit. The conclusion of the agreement resulted in the formation of the world's largest FTZs, and the Asian region, which accounts for 28.9% of the global economy, will be the focus of FT and investment. The implementation of the RCEP is expected to strengthen production linkages among the member countries and create a new international division of labor. In the RCEP with 15 participating countries, three countries, Japan, China, and the ROK, account for more than 80% of the economic scale. This is the first economic partnership agreement between Japan and China, its largest trading partner, and Japan and the ROK, its third-largest trading partner. The change in the cooperative relationship among the three countries will have a tremendous impact on economic integration in the East Asia region. In addition, tariffs will be eliminated on 91.5% of industrial products exported from Japan, including steel products, which are a key export item. To promote the sustainable development of the East Asia region and understand the impact of the RCEP agreement on the region, it is necessary to dynamically reexamine the international division of labor in the East Asia region and the trade structure of the steel industry in Japan, China, and the ROK. Therefore, this paper clarifies the trade structure of the steel industry through a time series analysis of the international division of labor for intermediate goods in the East Asia region since 1997 and the "metal products" industry in Japan, China, and the ROK using data from

the Asia International Industry Database (YNU-GIO)[1] (annual database) (Jin and Chen 2008).

## 2 Changes in the Trade Structure in the East Asia Region

In the development of the international division of labor in the East Asia region, we will look at the changes in the procurement rate of intermediate goods from within and outside the region for East Asian countries (regions) between 1997 and 2012 (METI 2012). Table 1 shows the changes in the ranking of the top 10 trading partners for intermediate goods in East Asian countries (regions) (Jin and Mori 2016).

In 1997, the USA was the top country that exported intermediate goods to Japan, followed by China and the ROK, which ranked second and third, respectively, and then Australia and Germany. In 2012, however, China overtook the USA, and China's became the largest exporter to Japan; there was also a noticeable increase in the import rate of intermediate goods from Asian countries, with Japan's imports from Asian countries exceeding those from other countries (regions) in 2012 compared to those in 1997.

In 1997, China's largest import of intermediate goods was from Japan, followed by the USA. Most of the countries (regions) in the top 10 were East Asian countries (regions), but their shares were not very large; in 2012, the USA reversed its position to become No. 1, but the increase in the import rate was not large. In addition to those from the USA, imports from Australia and the emerging economies of India and Brazil are also increasing. However, the total import rate from Asian countries (regions) is by far the largest.

Looking at the partner countries for the ROK's imports of intermediate goods, we see that other than China, the USA, and European countries were dominant in 1997. By 2012, imports from China had increased dramatically, while imports from the USA and European countries had declined. Imports from Australia and East Asian countries are also on the rise.

[1] The Asia International Industry Database (YNU-GIO Table) is a database published by the Research Center for Economic and Social Studies in Asia (ReCESSA), which is affiliated with the Faculty of Economics, Yokohama National University.

**Table 1** Change in intermediate goods imported from within and outside East Asian countries (regions) (unit: %)

| *Rank* | | *1997* | | *2012* |
|---|---|---|---|---|
| ***Japan*** | | | | |
| 1 | USA | 2.61 | China | 3.97 |
| 2 | China | 1.17 | USA | 2.54 |
| 3 | ROK | 0.52 | Australia | 1.68 |
| 4 | ROW | 0.40 | ROK | 0.87 |
| 5 | Australia | 0.39 | ROW | 0.61 |
| 6 | Germany | 0.39 | Indonesia | 0.58 |
| 7 | Thailand | 0.34 | Malaysia | 0.58 |
| 8 | Indonesia | 0.31 | Thailand | 0.53 |
| 9 | Taiwan | 0.28 | Germany | 0.52 |
| 10 | Canada | 0.26 | ROE | 0.44 |
| ***China*** | | | | |
| 1 | Japan | 2.16 | USA | 1.55 |
| 2 | USA | 1.22 | Japan | 1.52 |
| 3 | Taiwan | 1.11 | ROK | 1.48 |
| 4 | ROK | 1.10 | Australia | 1.07 |
| 5 | Germany | 0.56 | Germany | 0.98 |
| 6 | ROW | 0.55 | ROW | 0.82 |
| 7 | Singapore | 0.49 | Taiwan | 0.61 |
| 8 | Thailand | 0.32 | Brazil | 0.60 |
| 9 | Malaysia | 0.29 | India | 0.60 |
| 10 | Hong Kong | 0.26 | Malaysia | 0.54 |
| ***ROK*** | | | | |
| 1 | USA | 6.42 | China | 11.53 |
| 2 | Japan | 5.71 | Japan | 5.38 |
| 3 | China | 4.08 | USA | 5.09 |
| 4 | ROW | 1.41 | Australia | 2.68 |
| 5 | Germany | 1.39 | Germany | 1.74 |
| 6 | Australia | 1.09 | ROW | 1.58 |
| 7 | UK | 0.91 | Indonesia | 1.14 |
| 8 | Italy | 0.72 | Malaysia | 1.06 |
| 9 | Indonesia | 0.63 | ROE | 0.98 |
| 10 | Singapore | 0.56 | OPEC | 0.93 |
| ***Malaysia*** | | | | |
| 1 | Japan | 8.90 | China | 6.83 |
| 2 | USA | 6.84 | Singapore | 5.79 |
| 3 | Singapore | 6.80 | USA | 4.22 |

(continued)

**Table 1** (continued)

| *Rank* | | *1997* | | *2012* |
|---|---|---|---|---|
| 4 | China | 4.42 | Japan | 3.17 |
| 5 | Thailand | 3.69 | India | 2.66 |
| 6 | ROW | 2.42 | Indonesia | 2.48 |
| 7 | Germany | 2.24 | Thailand | 2.42 |
| 8 | Taiwan | 2.22 | ROW | 1.80 |
| 9 | ROK | 2.16 | Taiwan | 1.74 |
| 10 | Indonesia | 1.89 | Germany | 1.50 |
| ***Indonesia*** | | | | |
| 1 | Japan | 3.48 | China | 4.77 |
| 2 | USA | 2.41 | Singapore | 2.07 |
| 3 | China | 2.22 | Japan | 1.78 |
| 4 | Singapore | 1.37 | USA | 1.69 |
| 5 | ROK | 1.09 | Malaysia | 1.33 |
| 6 | Australia | 0.89 | Thailand | 1.23 |
| 7 | Germany | 0.89 | OPEC | 1.13 |
| 8 | ROW | 0.85 | ROK | 1.07 |
| 9 | Malaysia | 0.83 | India | 1.03 |
| 10 | Thailand | 0.82 | Australia | 0.99 |
| ***Philippines*** | | | | |
| 1 | USA | 8.21 | China | 4.76 |
| 2 | Japan | 6.81 | USA | 3.52 |
| 3 | China | 3.01 | Singapore | 2.56 |
| 4 | Singapore | 2.89 | Japan | 1.88 |
| 5 | ROK | 2.17 | Taiwan | 1.63 |
| 6 | Taiwan | 2.02 | Malaysia | 1.36 |
| 7 | Thailand | 1.21 | ROK | 1.06 |
| 8 | ROW | 1.19 | Thailand | 0.83 |
| 9 | Germany | 1.04 | Australia | 0.78 |
| 10 | Australia | 1.03 | Indonesia | 0.75 |
| ***India*** | | | | |
| 1 | ROW | 1.12 | China | 5.45 |
| 2 | USA | 0.87 | ROW | 2.50 |
| 3 | China | 0.86 | USA | 1.82 |
| 4 | UK | 0.77 | Malaysia | 1.21 |
| 5 | Japan | 0.73 | OPEC | 1.19 |
| 6 | Germany | 0.68 | Indonesia | 1.15 |
| 7 | Malaysia | 0.54 | Germany | 1.14 |

(continued)

**Table 1** (continued)

| *Rank* | | *1997* | | *2012* |
|---|---|---|---|---|
| 8 | Belgium | 0.52 | ROK | 1.05 |
| 9 | Italy | 0.37 | Australia | 1.04 |
| 10 | Indonesia | 0.31 | Japan | 0.92 |
| ***Australia*** | | | | |
| 1 | USA | 3.91 | China | 2.67 |
| 2 | ROW | 1.93 | ROW | 2.26 |
| 3 | Japan | 1.71 | USA | 2.13 |
| 4 | UK | 1.03 | Malaysia | 1.12 |
| 5 | Indonesia | 0.84 | Indonesia | 0.80 |
| 6 | China | 0.83 | Japan | 0.70 |
| 7 | Germany | 0.81 | Singapore | 0.58 |
| 8 | Italy | 0.57 | Germany | 0.57 |
| 9 | Singapore | 0.48 | Thailand | 0.54 |
| 10 | ROK | 0.46 | UK | 0.51 |
| ***USA*** | | | | |
| 1 | Canada | 1.68 | Canada | 2.60 |
| 2 | Japan | 1.48 | China | 2.04 |
| 3 | Mexico | 0.99 | Mexico | 1.38 |
| 4 | ROW | 0.64 | Japan | 0.85 |
| 5 | Germany | 0.64 | ROW | 0.83 |
| 6 | UK | 0.63 | Germany | 0.75 |
| 7 | China | 0.57 | UK | 0.57 |
| 8 | France | 0.40 | India | 0.50 |
| 9 | Italy | 0.40 | ROK | 0.41 |
| 10 | Taiwan | 0.30 | Brazil | 0.41 |
| ***Canada*** | | | | |
| 1 | USA | 19.96 | USA | 15.96 |
| 2 | ROW | 1.46 | China | 2.09 |
| 3 | UK | 1.42 | ROW | 1.48 |
| 4 | Japan | 1.10 | Mexico | 1.02 |
| 5 | Mexico | 0.71 | UK | 0.70 |
| 6 | Germany | 0.62 | Japan | 0.65 |
| 7 | China | 0.59 | Germany | 0.60 |
| 8 | Italy | 0.54 | OPEC | 0.57 |
| 9 | OPEC | 0.51 | ROA | 0.54 |
| 10 | France | 0.42 | Brazil | 0.42 |
| ***Germany*** | | | | |

(continued)

**Table 1** (continued)

| *Rank* | | *1997* | | *2012* |
|---|---|---|---|---|
| 1 | ROW | 2.61 | ROE | 5.27 |
| 2 | France | 2.22 | ROW | 3.70 |
| 3 | Italy | 2.18 | Netherlands | 3.48 |
| 4 | ROE | 1.92 | China | 2.84 |
| 5 | UK | 1.89 | USA | 2.68 |
| 6 | USA | 1.88 | UK | 2.25 |
| 7 | Netherlands | 1.83 | France | 2.14 |
| 8 | Belgium | 1.15 | Italy | 2.13 |
| 9 | Austria | 0.94 | Austria | 1.81 |
| 10 | Japan | 0.81 | Belgium | 1.71 |
| ***Italy*** | | | | |
| 1 | Germany | 2.96 | Germany | 3.44 |
| 2 | France | 2.48 | ROE | 2.29 |
| 3 | ROW | 1.80 | China | 1.92 |
| 4 | UK | 1.29 | ROW | 1.80 |
| 5 | USA | 1.21 | France | 1.73 |
| 6 | Belgium | 0.89 | Netherlands | 1.26 |
| 7 | Netherlands | 0.89 | USA | 1.25 |
| 8 | Spain | 0.88 | Spain | 1.20 |
| 9 | ROE | 0.87 | ROA | 0.95 |
| 10 | Austria | 0.56 | Belgium | 0.94 |

*Note* ROW (Rest of the World), ROE (Rest of Europe), ROA (Rest of Asia)
*Source* ReCESSA, prepared by the author

Looking at the partner countries for Malaysia's imports of intermediate goods in 1997, we see that Japan, the USA, and Singapore ranked first, second, and third, respectively. Asian countries (regions), the USA and Germany, accounted for the top 10 exporting countries. However, in 2012, China ranked first, and the percentages of imports from India and Indonesia increased significantly; additionally, the import rates of many of the top 10 countries (regions) in 1997 decreased.

Looking at the partner countries for Indonesia's imports of intermediate goods, we see that Japan ranked first in 1997, and the USA and China ranked second and third, respectively, but the differences were not large. Imports from Singapore and the ROK were also notable. By 2012, imports from China and Singapore had increased, and the percentage of imports from Singapore exceeded that from Japan. Imports from Europe declined, but imports from OPEC countries and India increased.

Among the partner countries from which the Philippines imported intermediate goods, the USA was the largest exporter in 1997, followed by Asian countries (regions). By 2012, China had overtaken the USA as the largest exporter, and imports from Asian countries (regions) increased as well.

Among countries from which India imported intermediate goods, European countries dominated in 1997. However, by 2012, imports from Europe had decreased, and imports from China had increased substantially. Imports from Japan were low, while imports from Malaysia, OPEC countries, and Indonesia increased substantially.

As described above, the trade structure of intermediate goods in the East Asia region is characterized by the following trends. (1) In 2012, China, known as the "world's factory," became the leading exporter to Asian countries in both name and reality. In recent years, while China has increased its share of imports from East Asian countries (regions), it has also increased its imports from global countries, including the USA, European countries, Australia, South America, and the emerging nation of India. (2) Europe, which accounted for a large share of East Asian countries' (regions') imports in 1997, saw its share of intermediate good exports decreased significantly in 2012. (3) Japan, China, and the ROK have all experienced significant increases in trade with Australia. (4) Malaysia, Indonesia, and the Philippines are deepening their trade ties with Singapore. (5) India, as an emerging country, is strengthening its ties with Asian countries and expanding trade with OPEC countries. Thus, intraregional trade relations have generally strengthened in East Asia.

Now, we focus on the countries from which Australia imports intermediate goods. Imports from the USA and Europe decreased in 2012 compared to those in 1997, but imports from East Asia increased nearly 1.5 times. Among the countries from which the USA imports intermediate goods, in 1997, with the exception of Japan, which ranked second, the USA mainly traded with countries that had signed the North American Free Trade Agreement (NAFTA), and other than that, trade with Europe accounted for most of the USA imports. In 2012, China overtook Japan to rank second, and imports to the USA from India and the ROK increased. The top nations in terms of imports have remained almost unchanged. As of 1997, Canada's imports of intermediate goods were mostly from Japan and China, but by 2012, imports from other

Asian countries had increased. Germany and Italy mainly imported intermediate goods from European countries, except for the USA, in 1997. By 2012, imports from China had increased.

From the above information, the East Asia region's trade relations with the rest of the world can be summarized as follows. (1) European countries procure intermediate goods from within the EU. (2) Australia is actively procuring intermediate goods from East Asian countries (regions), and the USA imports little from East Asian countries (regions) other than China, India, and the ROK.

In general, the interrelationship between intraregional and extraregional trade in East Asia suggests that East Asian countries (regions) have an active intraregional division of production for intermediate goods.

## 3 Changes in the Trade Structure in Japan, China, and the ROK (by Sector)

Japan, China, and the ROK are influential countries in East Asia with close interrelationships for economic and environmental issues; additionally, economic promotion and international cooperation among the three countries will be very important in promoting the RCEP in the future. To clarify the interdependence of trade among the three countries, this paper analyzes data from 29 endogenous countries (including 11 Asian countries), 59 exogenous countries, and 35 industry sectors[2] from the YNU-GIO Table (Table 2) (Jin and Mori 2016). From 1997 to 2012, a study showed that the procurement of intermediate goods among Japan, China, and the ROK peaked in 2007 and declined in many sectors due to the impact of the Lehman Shock. However, some sectors exhibited a recovery in procurement among the three countries after the Lehman Shock.

The present study analyzed the "chemical products," "metal products," "machinery and equipment," "electronics and electrical equipment," "transport machinery," and "construction" sectors, which are the large input–output sectors in the three countries. From the sectoral data in Fig. 1, Japan's imports from China's "metal products" sector displayed a noticeable rise from 1997 to 2007 but a downward trend after peaking in 2007. The trends for the "machinery and equipment"

[2] In this paper, the 35 sectors were combined into 18 sectors (Table 2) for analysis.

**Table 2** Sectoral integration in the Asian international input–output table

| *Code* | *Sectors* | *Code* | *Sectors* |
|---|---|---|---|
| 1 | Agriculture | 10 | Machinery and equipment |
| 2 | Mining | 11 | Electronic and electrical equipment |
| 3 | Food products, beverages, and tobacco | 12 | Transport equipment |
| 4 | Textiles and clothes | 13 | Other manufacturing |
| 5 | Wood and paper products | 14 | Construction |
| 6 | Coke and petroleum products | 15 | Electricity, gas and water supply |
| 7 | Chemical products | 16 | Transport |
| 8 | Nonmetallic mineral products | 17 | Computer and related activities |
| 9 | Metal products | 18 | Services |

*Source* ReCESSA, prepared by the author

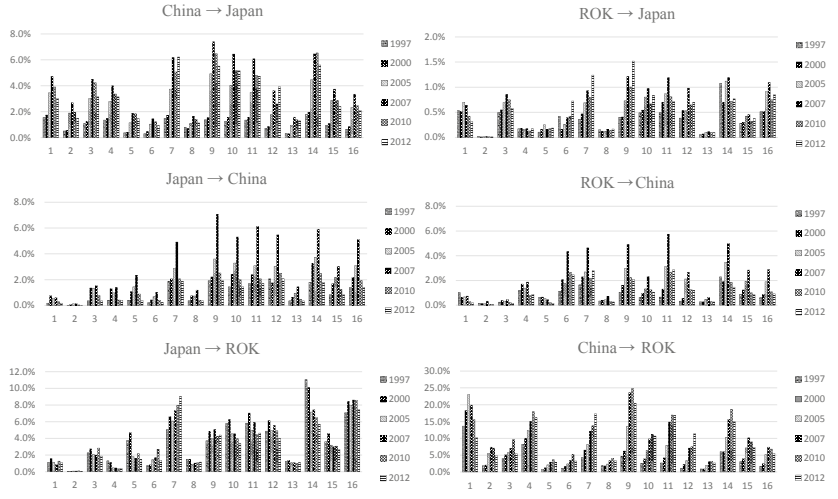


**Fig. 1** Supply and demand by sector in Japan, China, and the ROK (unit: %) (*Source* ReCESSA, prepared by the author)

and "electronics and electrical equipment" sectors have remained flat since 2007. Imports from the "chemical products" sector temporarily declined after the collapse of Lehman Brothers but later returned to 2007 levels. In the "construction" sector, procurement rose until 2010 and

then declined. Japan's imports from the ROK's "metal products" and "chemical products" sectors peaked in 2007 and then declined before eventually increasing in 2012, with the corresponding level far exceeding the 2007 level. Imports from the "electronics and electrical equipment" sector peaked in 2007 and then declined, falling to the level observed in the early 2000s. The "construction" and "transportation" sectors peaked in 2007 and then declined, with notable recovery in 2012.

In the "metal products," "chemical products," "electronics and electrical equipment," "transport machinery," and "construction" sectors, for which China's imports of intermediate goods from Japan are large, all procurements peaked in 2007 and then declined to below the level observed in 2000 (with the exception of the "transportation machinery" sector). China's imports from the ROK's "metal products" and "construction" sectors peaked in 2007 and have since declined. In contrast, procurement from the "chemical products" and "electronics and electrical equipment" sectors has shown a recovery since 2007.

The ROK's imports from Japan's "chemical products" sector have continued to rise regardless of the impact of the Lehman Shock. Imports from the "electronics and electrical equipment" and "transport machinery" sectors peaked in 2000 and have been on a downward trend ever since. Procurement from the "construction" sector, which had the largest weight in terms of the ROK's imports from Japan, has continued to decline. The ROK's imports from China have increased for the "chemical products" sector and now far exceed those from Japan. In the "textiles and clothing," "metal products," and "construction" sectors, procurement rose from 1997 to 2010 and slowed in 2012.

Next, the interdependence among Japan, China, and the ROK was assessed. Japan's dependence on the "machinery and equipment" sectors in China and the ROK has increased. Additionally, both China and Japan have increased their dependence on the ROK's "chemical products" sector, and both China and the ROK have decreased their dependence on Japan's "electronics and electrical equipment," "transport machinery," and "construction" sectors. In addition, both Japan and the ROK have seen a decline in their dependence on China's "metal products" and "construction" sectors, while Japan's dependence on the ROK's "metal products" sector has increased since the Lehman Shock. The decline in dependence on the "metal products" sector is partly due to the decline

in demand following the financial crisis, but it is necessary to look further into the supply and demand structure of metal products among the three countries.

## 4 Interdependence in the "Metal Products" Industry Among China, Japan, and the ROK

Figure 2 shows the supply from the "metal products" sector to other sectors[3] within Japan, China, and the ROK.

In Japan, compared to that in 1997, the supplies from the "metal products" sector to the "electronic and electrical equipment" (3.92–3.18%) and "transportation machinery" (3.48–3.05%) sectors within the country continuously decreased, while the supplies to the "machinery and equipment" (4.77–5.10%) and "construction" (7.88–9.11%) sectors increased. The largest demand can be observed for the "construction" sector.

In China, the supplies from the "metal products" sector to the "machinery and equipment" (9.51–11.05%), "electronics and electrical equipment" (6.61–7.35%), "transportation machinery" (7.13–9.21%), and "construction" (8.74–10.08%) sectors displayed an increasing trend compared to the levels in 1997. The largest demand can be observed for the "machinery and equipment" sector.

In the ROK, the supplies from the "metal products" sector to the "machinery and equipment" (5.40–6.31%), "electronics and electrical equipment" (1.86–2.40%), "transportation machinery" (2.99–4.01%), and "construction" (6.54–7.83%) sectors have increased compared to the levels in 1997. Demand is highest for the "construction" sector.

Figure 3 shows the supply from the "metal products" sector in Japan, China, and the ROK to other sectors in other countries. To meet the demand from various sectors in Japan, supply from China's "metal products" sector to Japan peaked in 2007 and has been declining since the Lehman Shock in 2008, while supplies to the "machinery and equipment" (0.13–0.56%), "electronics and electrical equipment" (0.10–0.38%), and "construction" sectors (0.12–0.54%) have risen significantly since 2005 compared to the levels in 1997. The "transportation machinery" sector (0.11–0.58%) has displayed a recovery trend since 2010. The supply from the ROK's "metal products" sector to Japan was temporarily

[3] Other sectors refer to sectors other than the "metal products" sector.

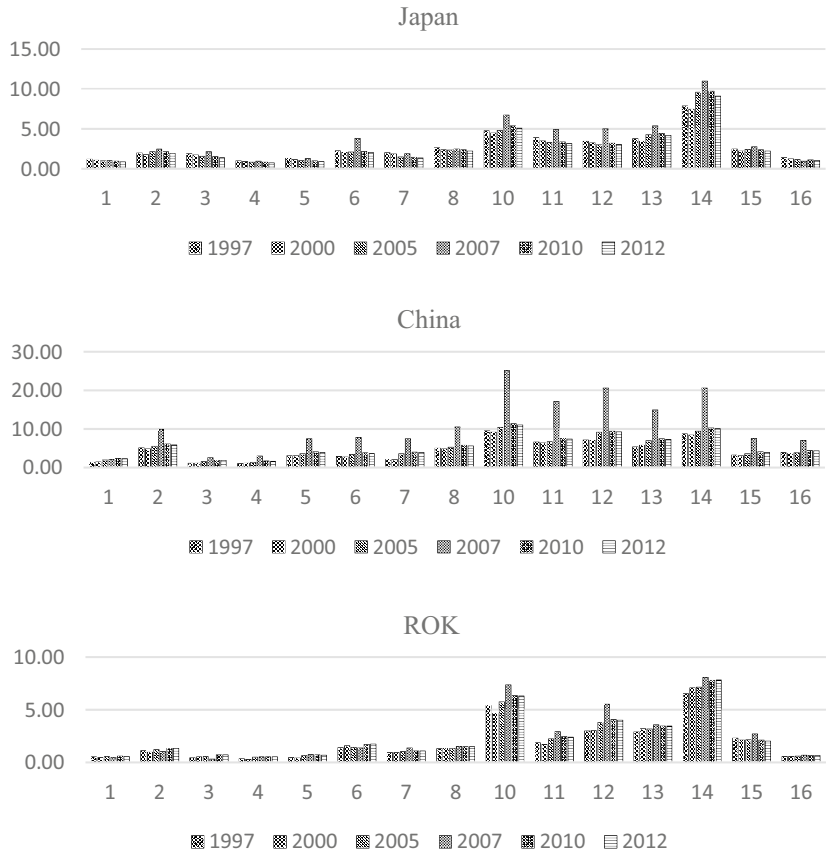


**Fig. 2** Supply from the "metal products" sector to other sectors in the same country (unit: %) (*Source* ReCESSA, prepared by the author)

affected by the Lehman Shock, but since 2010, the supplies to the "machinery and equipment" (0.03–0.14%), "electronics and electrical equipment" (0.02–0.08%), "transportation machinery" (0.03–0.10%), and "construction" (0.05–0.18%) sectors have increased significantly.

The supply from Japan's "metal products" sector to meet the demands from the following sectors in China was large: "machinery and equipment" (0.29–0.18%), "electronics and electrical equipment" (0.21–0.14%), "transportation machinery" (0.23–0.17%), and "construction"

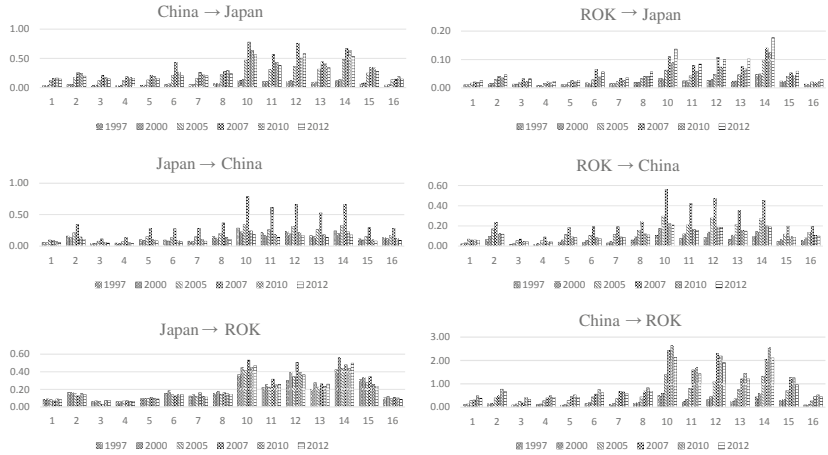


**Fig. 3** Supply from the "metal products" sector in a country to other sectors in other countries (unit: %) (*Source* ReCESSA, prepared by the author)

(0.24–0.18%). However, all four sectors experienced decreases in their shares compared to those in 1997. The supplies from the ROK's "metal products" sector to China's "machinery and equipment" (0.11–0.21%), "electronics and electrical equipment" (0.08–0.16%), "transportation machinery" (0.09–0.18%), and "construction" (0.10–0.19%) sectors were large.

The supply from Japan's "metal products" sector to meet the demands from various sectors in the ROK, namely, the "machinery and equipment" (0.37–0.47%) and "electronics and electrical equipment" (0.22–0.26%) sectors, declined after peaking in 2007 but exhibited a recovery trend in 2012. In the "transportation machinery" sector (0.30–0.37%), the supply share peaked in 2007 and has since declined. In addition, the "construction" sector (0.42–0.50%) displayed an increase in its supply share, although this share did not reach the level observed in 2000. The supplies from China's "metal products" sector to the "machinery and equipment" (0.51–2.13%), "electronics and electrical equipment" (0.25–1.43%), "transportation machinery" (0.32–1.91%), and "construction" (0.43–2.10%) sectors have increased, with shares significantly exceeding those in 1997.

Figure 4 shows the demands from the "metal products" sectors in

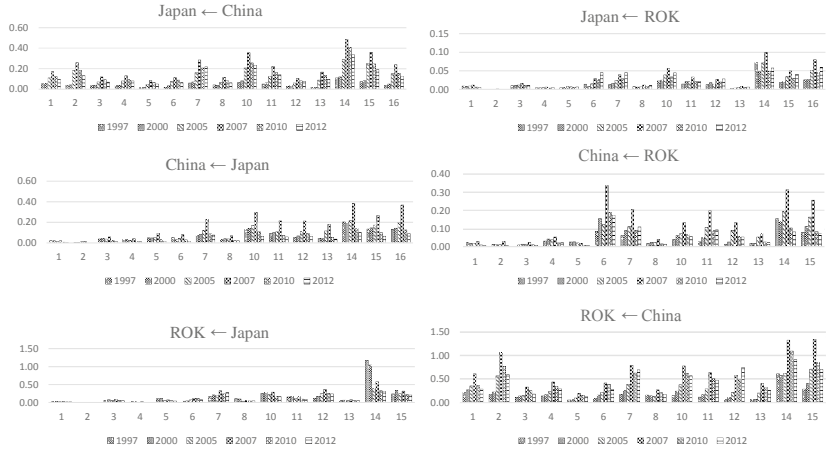


**Fig. 4** Demand of the "metal products" sector in a country for other sectors in other countries (unit: %) (*Source* ReCESSA, prepared by the author)

Japan, China, and the ROK for intermediate goods from other sectors in other countries. Japan's "metal products" sector has large demands associated with the "mining" (0.04–0.13%), "chemical products" (0.06–0.22%), "machinery and equipment" (0.06–0.23%), and "construction" sectors (0.11–0.34%) in China, all of which have seen their share decreases since peaking in 2007. Demand from Japan's "metal products" sector to the ROK has continued to increase for the "coal and petroleum products" (0.01–0.04%) and "chemical products" (0.01–0.04%) sectors. In the "construction" sector (0.07–0.06%), the demand is lower than that in 1997.

Demand from China's "metal products" sector for Japan's "machinery and equipment" (0.13–0.07%), "electronics and electrical equipment" (0.09–0.06%), and "construction" sectors (0.20–0.10%) has continued to decline, with the corresponding shares decreasing below the levels in 1997. In contrast, the demands for the "chemical products" (0.07–0.08%) and the "transport machinery" (0.05–0.07%) sectors have increased from the levels in 1997. The demand from China's "metal products" sector for the ROK's "coal and petroleum products" (0.08–0.17%), "chemical products" (0.06–0.11%), and "electronics and electrical equipment" (0.03–0.09%) sectors is higher than that in 1997,

and the corresponding shares have increased. Demand for the ROK's "machinery and equipment" (0.04–0.06%) sector peaked in 2007 and has been on a downward trend, while the demand for the "construction" sector (0.15–0.08%) has declined significantly, falling below the level in 1997.

There has been a continuous increase in the demand of the ROK's "metal products" sector for Japan's "chemical products" (0.16–0.28%) sector. In contrast, the demands for Japan's "machinery and equipment" (0.26–0.16%), "electronics and electrical equipment" (0.16–0.09%), and "construction" sectors (1.18–0.31%) have continuously declined. Demand for the "transportation machinery" sector (0.12–0.24%) peaked in 2007 and has been on a downward trend. The demand of the ROK's "metal products" sector for China's "mining" sector (0.17–0.60%) peaked in 2007 and has generally declined but remains significantly above the level in 1997. Demand for China's "machinery and equipment" (0.15–0.58%) and "electronics and electrical equipment" (0.12–0.48%) sectors peaked in 2007 and has been on a downward trend. The demands for China's "chemical products" (0.18–0.70%) and "transportation machinery" (0.07–0.75%) sectors have continued to increase.

The supply and demand structure of the "metal products" sectors in Japan, China, and the ROK can be summarized as follows: from 1997 to 2012, the subsectors with the highest demands for metal products in Japan, China, and the ROK were all concentrated in the "machinery and equipment," "electronics and electrical equipment," "transport machinery," and "construction" sectors. Affected by the 2008 Lehman Shock, the demand peaked in 2007 and has been declining ever since.

The supply structure of the "metal products" sector can be summarized as follows. China's steel sector accounts for the major share of the demand in Japan's "transportation machinery" sector. The ROK continues to increase its supply to meet Japan's demand in the "construction" sector. In 1997, Japan's supply share from the "metal products" sector was high to meet the demands of China's "machinery and equipment," "electronics and electrical equipment," "transportation machinery," and "construction" sectors, but this situation reversed in 2012, with the ROK's share surpassing that of Japan. Compared to that in 1997, the supply from China's "metal products" sector increased significantly in response to the demand from the ROK's "machinery and equipment," "transportation machinery," and "construction" sectors.

The increases in supply from the "metal products" sectors in China and the ROK to the "transportation machinery" and "construction" sectors reflect the increased production capacities of Chinese and the ROK's companies.

Based on the demand structure of the "metal products" sector, the "metal products" sectors in Japan and China both displayed an increase in demand for the "coal and petroleum products" sector in the ROK. In all three countries, the demand of the "metal products" sector for the "chemical products" sector increased, and the demand for the "construction" sector decreased.

## 5 Conclusions

This paper analyzed the international division of labor structure for intermediate goods in the East Asia region from the perspectives of the international division of labor, interdependence among East Asian countries, and dependence on other countries outside the region. The analysis revealed the following results. (1) China is increasing the number of global partners associated with the trade of intermediate goods, including the emerging market in India and steadily strengthening ties with East Asian countries. (2) In addition to China and Japan, the USA is increasing its imports from India and the ROK, but its ties with the rest of East Asia are weak. (3) Japan's share of intra-East Asian trade in intermediate goods is declining, and Japan's cooperation with India, an emerging country, is particularly lagging. (4) European countries are procuring intermediate goods within the EU. These results indicate that East Asian countries (regions) are experiencing an active division of production within the region. In addition, with the intensification of trade friction between the USA and China and the growing inclination toward protectionism, the conclusion of the RCEP agreement will strengthen cooperation among countries in the East Asia region.

This paper also analyzed the international division of labor structure and interdependence among Japan, China, and the ROK, as changes in economic promotion and cooperation among the three countries will have a significant impact on economic integration in the East Asia region under the RCEP, in which 15 countries are involved. Through the analysis, the following results were obtained. (1) The three countries are becoming increasingly interdependent in terms of the "chemical products" sector, indicating that competition among the three countries is

occurring or may occur in the future. (2) The interdependence of the "electronics industry" among the three countries is decreasing, which can be attributed to the transfer of production to Southeast Asia, as well as the economic development of Southeast Asian countries, which is increasing their competitiveness. (3) While both Japan and the ROK have seen a decline in their dependence on China's "metal products" and "construction" sectors, Japan's dependence on the ROK's "metal products" sector has increased since the Lehman Shock.

The decline in dependence on the "metal products" sector was partly due to the decline in demand after the financial crisis, but this paper further analyzed the supply and demand structure of the "metal products" sectors in Japan, China, and the ROK. From the demand structure, we see that in all three countries, the demand of the "chemical products" sector for the "metal products" sector increased. In terms of the supply structure, the following results were found. (1) Japan's supply from the "metal products" sector to China's major industrial sectors ("machinery and equipment," "electronics and electrical equipment," "transportation machinery," and "construction" sectors) was high, but the situation reversed in 2012, with the ROK's share surpassing that of Japan. (2) The supply from China's "metal products" sector to the ROK's major industrial sectors ("machinery and equipment," "transportation machinery," and "construction" sectors) has increased significantly. The increases in Chinese and the ROK's supplies from the "metal products" sector reflect the increased production capacities of Chinese and the ROK's companies.

In this paper, the "steel" sector was integrated into the "metal products" sector for the sake of classification. Since the "steel" sector occupies 80–90% of the "metal products" sector, it can be said that trends in the "metal products" sector reflect trends in the "steel" sector. According to a report by Japan's Ministry of Economy, Trade, and Industry (METI), while profit margins in the "transportation machinery" and "construction" sectors, the main industries with large demands in Japan were higher in 2013 than they were before the Lehman Shock, the demand in the "steel" sector is less than one-third of its pre-Lehman Shock level. The background to this situation is as follows. As shown in the analysis, Chinese and the ROK's companies are increasing their production capacities, which is causing a deterioration in the global steel market. In addition, in a move to reorganize the global steel industry, the Chinese government launched the "Automobile and Steel Industry Adjustment Plan" in 2009 with the aim of upgrading the industrial structure (Koga

2011). For steel, this plan is aimed at improving quality and building international competitiveness. In the ROK, it is reported that R&D expenses are being increased to strengthen international competitiveness. Chinese and the ROK's manufacturers are accelerating their pursuit of technology, and in the near future, a competitive system will be formed among Japan, China, and the ROK for high-value-added, high-grade steel products. Moreover, the shift in global steel demand to emerging countries is expected to progress further as developed countries continue to experience sluggish growth in the medium to long term. The demand for steel is expected to increase due to the growing demands for infrastructure and logistical networks as supply chains are restructured in the Southeast Asia region. For steel products other than those involving high-grade steel, the production and supply in Southeast Asia are expected to increase significantly. In addition, the ongoing transfer of overseas production bases to Southeast Asia has led to concerns about the environmental impact if there is insufficient support for measures to reduce $CO_2$ emissions associated with the growth of the steel industry in emerging economies.

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