PRODUCTION SHARING IN EAST ASIA: CHINA'S POSITION, TRADE PATTERN AND TECHNOLOGY UPGRADING*

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Abstract

International production sharing has been a key feature of East Asian economic development in recent decades, with firms in advanced Asian economies relocating their production to China, using it as an assembly base and exporting the final products to the United States and Europe. China has taken advantage of this process and transformed into a global manufacture centre, with the country's emergence having reshaped the Asian production network and trade pattern. This chapter analyses the economic model and development strategy in East Asia, China's position in East Asia's production network, as well as its impact on China's technological upgrading. We find that China has moved to the centre of East Asia's production network, thanks to its export-led development strategy. It has significantly upgraded its technology and narrowed its technology gap with ASEAN-4, although the gap between China and Asian more-advanced economies remains fairly large and noticeable.

Introduction

East Asia has followed a so-called "flying geese" development model since around the 1950s. The main driver of the model is the leader's imperative for internal restructuring due to increasing labour costs. As the evolving comparative advantages of Japan caused it to shift increasingly further away from labour-intensive production to more capital-intensive activities, the country shed its low-productivity production to nations further down in the hierarchy in a pattern that subsequently reproduced itself between the countries in the lower tiers (Kasahara, 2004). Under this model, the gross domestic product (GDP) of many economies in this region has more than tripled in three decades. Led by Japan, followed by Asia's newly industrialized economies (NIEs), later joined by ASEAN-4 (i.e. the four major economies in the Association of South-East Asian Nations (ASEAN), namely Indonesia, Thailand, Malaysia and the Philippines) and finally China, Viet Nam and Cambodia, the Asian economies took off one after another across half a century. During the same period, East Asia experienced an unprecedented change in its industrial relationship and international trade patterns. Prior to the 1970s, East Asian trade was dominated by a typical North-South vertical division of labour, whereby trade between Japan and developing Asia was characterized as typical inter-industry trade. The developing Asian economies exported resource-based and labour-intensive products to Japan, while Japan exported a wide range of final manufactured goods to its Asian neighbours. Subsequently, Japan shifted from labour- to

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capital-intensive industries in the 1970s due to the rising labour costs, while the Asian Tigers (Hong Kong (China), the Republic of Korea, Taiwan Province of China and Singapore) took over the labour-intensive manufactures. In the 1980s, Japan shifted further to high-technology industry, whereas the Asian NIEs took over some of the capital-intensive sectors and passed the labour-intensive sectors to the ASEAN-4 newcomers. Therefore, we observed a kind of three-layer inter-industry trade between Asian countries, in a trade pattern well explained by classical trade theory (Ando, 2006).

However, in the last two decades, and particularly the last 10–15 years, two important changes have emerged in East Asia. First, international production sharing[1] has become a unique feature of the region's economic landscape. Trade in parts and components (trade fragmentation) has not only grown faster than in any other part of the world, but also faster than Asia's trade in final goods. The production process is vertically sliced within one industry shared between East Asian economies, with each country/economy specialized in a particular stage of production. The consequence of this production sharing is the increased inter-dependency between more-developed and developing Asia nations. More-developed Asian countries and NIEs depend on developing Asia's cheap labour, rich resources and lucrative markets, while developing Asian countries depend on the importation of high-technology parts and components from Japan, the Republic of Korea and Taiwan Province of China. Secondly, China has moved from a periphery country to the centre of the Asian production network, transforming from a primary good supplier to a major manufacturing and assembly centre within the regional production network. Indeed, many questions have arisen from these changes: What are the new trends of trade and production in East Asia? What is the impact of the production sharing on the trade balance in East Asian countries? Has China successfully upgraded its technology level by moving upward in the value chain? What is the impact of the production sharing on China's export competitiveness?

This chapter analyses the development and trends of production sharing and the trade pattern in East Asia, China's participation and its role in this network, as well as the impact of production sharing on China's technology upgrading and trade competitiveness. The study focuses on trade in "machinery and transport equipment", category 7 of the Standard International Trade Classification (SITC), and "miscellaneous manufactured articles" (SITC, category 8), given that these two categories account for more than 70 per cent of China's exports and around 50 per cent of China's imports. Moreover, these two categories are the most integrated industries in East Asia and the best examples of production sharing in the region. The data that we use is mostly from the United Nations Commodity Trade Statistics (*Comtrade*) database, while some is from national trade statistics. The remainder of this chapter is structured as follows. Section I reviews existing literature on this issue and related topics. Section II analyses the evolution and current situation of production sharing and trade fragmentation in East Asia, as well as China's role in the network and how it has changed. Section III discusses the impact of this phenomenon on China's trade balance and technology upgrading. Section IV presents the key conclusions and policy implications.

I. Literature review

International production sharing, namely the cross-border splitting of the production process within vertically integrated manufacturing industries, has been a key facet of economic integration over recent decades, particularly in East Asia. The associated spatial diversification of production activities has been the main driver of the rapid growth of trade in parts and components between developed and developing countries, largely motivated by taking advantage of cheap production costs in developing countries. Many alternative names have been coined for such a phenomenon, including "slicing the value chain" (Krugman, 1995), "vertical specialization" (Hummels et al., 2001), "international production sharing" (Ng and Yeats, 1999 and 2001) and "outsourcing" (Hanson et al., 2001).

There is a sizeable body of theoretical literature examining the causes and modalities of international product sharing, as well as its implications for trade flows and policies (Cantwell, 1994; Venables, 1999; Jones, 2000; Jones and Kierzkowski, 2001; Jones et al., 2005; Baldwin, 2001; Deardorff, 2001). This literature assumes that intra-industry trade is much

more sensitive to inter-country differences in technology, labour supply, logistic efficiency and the overall production costs than inter-industry trade. Therefore, globally intra-industry trade has been growing faster than inter-industry trade due to the differences in processing technology production costs. Vertical intra-industry trade is growing faster than the horizontal intra-industry trade, particularly in East Asia.

Although trade in parts and components has generally grown faster than total world trade in manufacturing goods, the degree of East Asia's dependence on this new form of international specialization is proportionately larger than in North America and Europe. Accordingly, literature on the Asian production network and trade fragmentation have mushroomed since the early-2000s (Athukorala, 2003, 2011 and 2012; Ng and Yeats, 2001 and 2003; Athukorala and Yamashita, 2006 and 2008).

Most of the literature focuses on four areas: (a) the evolution and features of the East Asia production network (Ando, 2006; Kimura and Ando, 2005; Kimura et al., 2007; Athukorala, 2012; Athukorala and Yamashita, 2006; Ando and Kimura, 2003 and 2010); (b) the causes of East Asian production sharing and trade fragmentation (Ando and Kimura, 2003; Kimura, 2009); (c) the determinants of East Asian trade in parts and components (Athukorala and Yamashita, 2006; Kimura et al., 2007); and (d) China's role and impact upon East Asian production networks (Haddad, 2007; Yu and Xu, 2010; Yu and Wang, 2012).

Although the topic has been intensively explored in last ten years, the conclusions and opinions remain strongly divergent, particularly concerning China. This country is a relative newcomer in the Asia economic network. It has a different economic and political system and industrial structure and is far larger than other East Asian developing economies in terms of size of land, population and resources endowment. Moreover, China began its integration as an extremely poor country with low education and technology levels.

From a methodology perspective, three main methods have been applied to analyse the international production sharing. The first such method involves measuring vertical specialization using input-output data, as developed by Hummels et al., 1998 and 2001; Ishii and Yi, 1997). The second method is to analyse trade in parts and components flow, identifying the vertical inter-industry trade relationship between countries and economies (Ando, 2006; Athukorala and Yamashita, 2006 and 2009; Ando and Kimura, 2008; Falguni, 2012). Finally, the third method is to analyse the intra-firm trade of multinational enterprises, identifying its impact on economic integration (Hanson et al., 2005; Miroudot et al., 2009).

Although the first method has been widely used in many analyses, it has some drawbacks in terms of identifying a country's position in the international production network, particularly in developing countries where the data quality is not good. This method requires data for measuring foreign input or intermediary products among the total exports of a specific industry in one country. In China, there are different ways to calculate foreign inputs.[2] This causes vast differences in terms of estimating a vertical specialization index. The third methodology relates more to the enterprise level and could potentially better identify the technology level of one country in a certain production network, although enterprise-level data in China is not easy to obtain. Furthermore, China has a majority of State-owned enterprises in the so-called scaled enterprises, whose data does not always fit with the international statistical system. Therefore, this chapter follows the second method, using the *Comtrade* database.

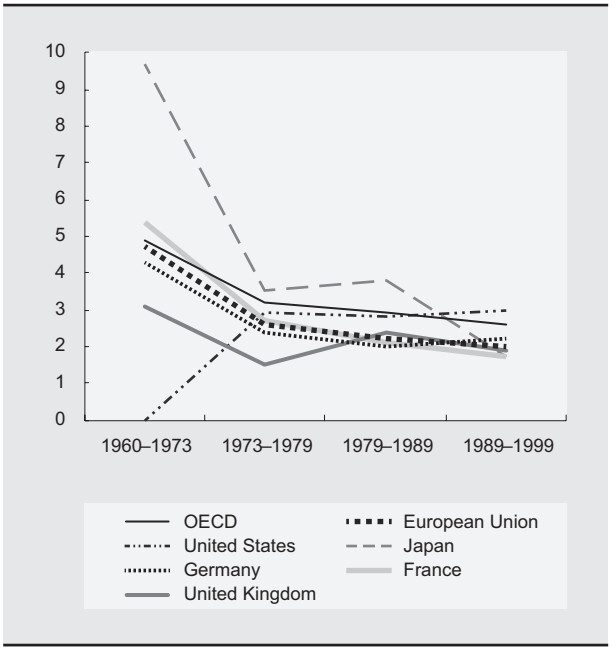
II. East Asia production network: From the flying geese model to production sharing

From the 1950s to the 1990s, East Asia followed a so-called "flying geese model" in which one country leads others towards industrialization step-by-step with a V-shaped formation. The leader of the region passes its older industries (normally low-value-added, lower-technology based industries) down to the followers as its own production cost rises and it moves into newer industries (higher-value-added, high-technology-based industries). From labour-intensive manufacture to capital-intensive

Chart 1

ANNUAL GDP GROWTH RATES AVERAGE IN SELECTED OECD COUNTRIES, 1960–1999

(Per cent)



Source: Author's calculations, based on OECD database.

manufacture and subsequently high-technology-intensive manufacture, the leader passes down its obsoleted industries to its close followers while upgrading its own industrial technologies.

The flying geese model started soon after the Second World War, led by Japan, immediately followed by the NIEs and subsequently by the ASEAN-4 economies. China followed in the 1980s, as well as more recently Viet Nam and Cambodia. As the changes in comparative advantages of the "leading goose" oblige it to shift further away from low value-added production to more value-added and technology-intensive activities, it relocates the labour-intensive production to the followers through foreign direct investment (FDI). The cornerstone of the flying geese model is the waterfall technological hierarchy and differences of labour costs between East Asian countries, which allows vertical inter-industry division of labour in the region.

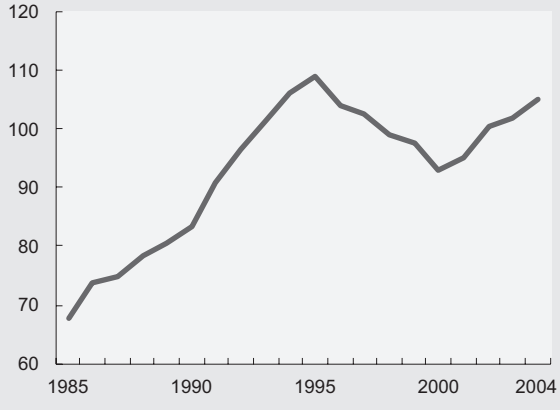
However, by the end of the 1990s, some new factors shook the foundation of the flying geese model, calling into question its ability to keep explaining Asian trade flows. One such factor is the slowing down of the Japanese economy (as shown in chart 1). As the leader, the Japanese economy was the fastest among Organisation of Economic Cooperation and Development (OECD) countries during the 1960s, 1970s and most of the 1980s, although it stagnated for about 20 years thereafter. The annual GDP growth rate in Japan dropped from almost 10 per cent in 1960–1973 to only 1.7 per cent from 1989 to 1999. Japan's GDP growth rates were not only lower than its Asian followers, but also slower than the United States, the European Union (EU) and the OECD average.

Secondly, the technology gap between Japan and the Asian NIEs was significantly narrowed, particularly with the Republic of Korea. From chart 2, we can see that the country's firm's total factor productivity (TFP) had caught up with that of the Japanese firms by the 1990s. In some industries like lumber and wood, furniture and fixture, food and kindred products, the TFP of the Republic of Korea's firms has even surpassed that of the Japanese firms (Jung et al., 2008) (table 1). Therefore, the Asian NIEs are no longer receivers of the production activities shifted from Japan, but rather competitors of Japan in markets of high-technology products. Trade between Japan and Asian NIEs transformed from inter-industry trade into intra-industry trade.

Chart 2

TOTAL FACTOR PRODUCTIVITY CATCH-UP INDEX OF MANUFACTURING FIRMS OF THE REPUBLIC OF KOREA, 1985–2004

(Index numbers, Japanese firms = 100)



Source: Jung, Lee and Fukao (2008).

Note: The TFP level of all Japanese listed firms in each year was set at 100. The difference can be regarded as the percentage gap of TFP between the two countries because the values are natural log value of TFP. Data refer to the firm size-weighted mean of all manufacturing listed firms.

Table 1

PATTERNS OF CATCH-UP OF TOTAL FACTOR PRODUCTIVITY OF FIRMS IN THE REPUBLIC OF KOREA WITH THAT OF JAPANESE FIRMS, 1985–2004

(Index numbers, Japanese firms = 100)

Industry name	*1985*	*1990*	*1995*	*2000*	*2004*	*Catch-up pattern*
Food and kindred products	81.7	110.3	116.7	111.2	110.9	Over catch-up
Lumber and wood	124.5	141.1	131.8	137.9	150.9	Over catch-up
Furniture and fixtures	87.0	99.6	119.2	125.0	129.1	Over catch-up
Stone clay glass	80.0	92.2	108.9	108.6	112.6	Over catch-up
Petroleum and coal products	73.7	163.7	195.3	114.0	102.7	Just catch-up
Leather	108.5	104.3	128.0	121.1	104.2	Just catch-up
Fabricated metal	90.7	100.0	128.5	110.0	96.3	Just catch-up
Machinery non-electrical	91.8	92.5	122.0	110.2	108.5	Just catch-up
Electrical machinery	24.0	30.8	75.0	73.1	96.6	Just catch-up
Transportation equipment and ordnance	74.8	84.0	103.8	92.5	97.0	Just catch-up
Textile mill products	48.8	57.1	81.3	87.8	82.4	Under catch-up
Apparel	7.7	19.4	53.2	57.5	59.6	Under catch-up
Paper and allied	72.5	75.6	92.2	74.0	86.6	Under catch-up
Motor Vehicles	38.6	54.5	75.1	78.8	88.0	Under catch-up
Instruments	33.9	40.7	73.1	60.2	61.0	Under catch-up
Printing publishing and allied	81.6	98.4	106.4	111.1	88.3	Reverse catch-up
Chemicals	72.7	78.7	91.0	90.0	80.9	Reverse catch-up
Primary metal	67.2	70.0	89.2	78.8	61.3	Reverse catch-up
Rubber and misc. plastics	55.6	61.6	80.5	81.7	76.0	Reverse catch-up
Total	61.6	69.5	92.1	86.5	91.2	

Source: Jung, Lee and Fukao (2008).

Note: Data correspond to the average of the TFP gap of firms of the Republic of Korea from the TFP of Japanese industry. The values also refer to the percentage differences of TFP because they are natural log differences. Reverse catch-up refers to the industries the Republic of Korea had first caught up with Japan, later on been caught up again by Japan.

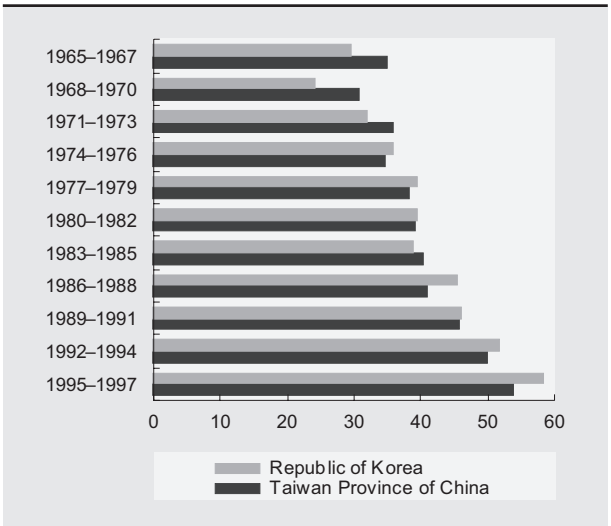
It can be evidenced by the export similarity between Japan and the Asian NIEs. As we can see from chart 3, Japan's export similarities with the Republic of Korea and Taiwan Province of China consistently increased from the 1960s to the 1990s. By the end of the 1990s, the Republic of Korea and Taiwan Province of China were competing with Japan in the export market of more than 50 per cent of the latter's exports.

Thirdly, the rise of China in the 1980s and 1990s further reshaped the regional industry landscape. China's manufacture technology and labour productivity dramatically improved thanks to the technology spillover from foreign-invested enterprises (FIEs) and the improved education and training system. In some sectors, the processing technology caught up or even overtook the ASEAN countries. China's role changed from being a follower of ASEAN-4 to a competitor in labour-intensive and medium-low-technology products, which led to a strong similarity in export products between China and the ASEAN countries.

Chart 3

JAPAN'S EXPORT SIMILARITY WITH THE REPUBLIC OF KOREA AND TAIWAN PROVINCE OF CHINA: 1965–1997

(Index numbers, complete similarity = 100)

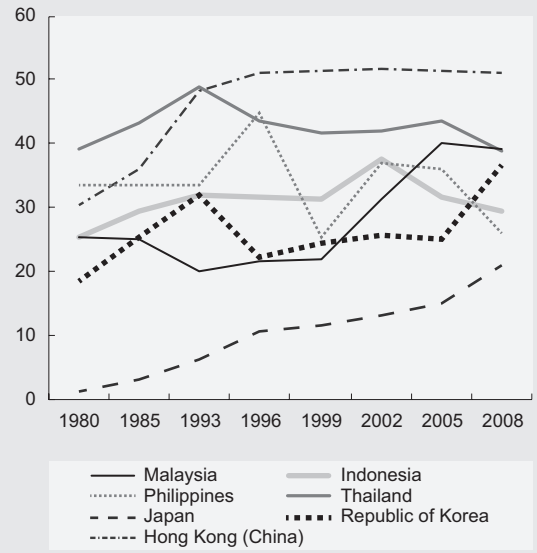


Source: Xu and Song (2002).

Chart 4

CHINA'S EXPORT SIMILARITY WITH SELECTED EAST ASIAN ECONOMIES, 1980–2008

(Index numbers, complete similarity = 100)



Source: Xu and Song (2002) and Loke (2009).

Note: Data for the 1980s are from Xu and Song (2002), those from 1990s and 2000s are sourced from Loke (2009). Since Xu and Song calculate the gross export similarity whilst Loke's calculates the net export similarity, there is some inconsistency with the numbers.

Chart 4 illustrates the interesting trends in the export similarity index between China and its East Asian neighbours. As we can see, China's export similarity with Japan and the Republic of Korea has been continuously increasing, although it remains relatively low. China's export similarity with Indonesia, the Philippines and Thailand initially increased between the 1980s and the early-1990s but decreased in the 2000s, and particularly after 2005. With Malaysia, the export similarity has continuously increased, reaching a similar level to Thailand in 2008. Export similarity with Hong Kong (China) is the highest, although it has not changed since the mid-1990s. This might be because China's industry technology has surpassed the ASEAN countries since the mid-2000s, becoming a competitor to Hong Kong (China), the Republic of Korea, Taiwan Province of China and Singapore.

Apart from changes in technology relationship, there have also been convergences of labour costs in Japan and the NIES, as well as between China and ASEAN-4, resulting in a change of the international division of labour in East Asia. The vertical intra-industry labour division, or production sharing, has replaced the inter-industry division. Within one industry, China, Japan, the Republic of Korea and Taiwan Province of China are focused on different production stages representing different levels of technology. The trade pattern in the region has also transformed from inter-industry trade to vertical intra-industry trade, which can be measured by the growing proportion of trade in parts and components in the total trade value. As illustrated by table 2, Asian trade of part and components as a share of trade in all manufacture products was growing considerably faster than in OECD Europe, North America and any other part of the world. By 2010, East Asian countries accounted for more than 40 per cent of the world's export in parts and components, as well as more than 35 per cent of the world's imports in parts and components. Within East Asia, exports in parts and components account for about one-third of the regional trade. It is particularly high in sectors such as electronics and telecommunication equipment. Almost three-quarters of all Asian imports of telecommunication equipment now comprise components for further assembly.

These trends were mainly driven by multinational enterprises (MNEs) relocating their production factories and reorganizing their business activities across different countries to reduce costs and improve their productivity. In East Asia, regional FDI roughly followed the technology hierarchy from Japan and the NIEs to China and ASEAN, helping the host countries to improve their labour productivity and technology.

Another noticeable change in East Asia is that China has moved from a peripheral country to being the centre of the East Asia production network. Due to the massive FDI flow from Hong Kong (China), Japan, the Republic of Korea, Taiwan Province of China and Singapore into China, East Asian MNEs have relocated a large percentage of their manufacturing bases to China, thus marking it as a new world factory by the end of the 2000s. As shown in table 3, China's share in world non-oil exports was merely 0.8 per cent in the early-1970s, whereas it had increased to 12.7 per cent by the end of the 2000s. During the same period, China's share in world manufacturing export also dramatically increased from 0.5 per cent to 14.9 per cent. Not only has the importance of China in Asia and global trade improved, but also the trade products structure of China has greatly improved, whereby manufacturing

Table 2

SHARE OF WORLD TRADE IN PARTS AND COMPONENTS, SELECTED COUNTRY GROUPS, 1992–2010

(Per cent)

	Exports					*Imports*				
	1992	*1996*	*2000*	*2005*	*2010*	*1992*	*1996*	*2000*	*2005*	*2010*
East Asia	34.5	38.3	39.5	40.8	42.1	33.5	32.8	33.1	34.1	35.3
NAFTA	28.2	24.0	23.9	23.4	22.8	33.5	25.8	27.5	27.0	26.3
European Union	32.8	38.0	30.9	30.3	28.3	35.1	33.8	31.5	30.3	29.1
Latin America	0.6	0.6	2.1	3.8	4.6	1.3	2.2	3.7	4.2	4.5
South Asia	0.2	0.2	0.1	0.2	0.3	0.7	0.4	0.5	0.5	0.5
Africa	0.1	0.2	0.1	0.1	0.2	0.4	0.9	0.4	0.4	0.5

Source: Author's calculations, based on United Nations, *Comtrade* database.

Table 3

SHARE IN WORLD NON-OIL TRADE AND MANUFACTURING TRADE, SELECTED ECONOMIES, 1969–2008

(Per cent)

	Total non-oil			*Manufacturing*			*Manufacturing share in total exports/imports*		
	1969/ 1970	*1989/ 1990*	*2007/ 2008*	*1969/ 1970*	*1989/ 1990*	*2007/ 2008*	*1969/ 1970*	*1989/ 1990*	*2007/ 2008*
Export									
China	**0.8**	**2.9**	**12.7**	**0.5**	**3.0**	**14.9**	**45.1**	**83.6**	**93.4**
Japan	6.3	10.4	4.6	8.9	12.7	7.4	93.4	98.0	93.2
Republic of Korea	0.3	2.2	3.0	0.3	2.6	3.5	75.4	93.6	87.6
Taiwan Province of China	0.6	2.7	2.0	0.6	3.1	2.4	71.5	91.9	91.8
Indonesia	0.3	0.5	0.9	0.0	0.4	0.6	3.8	55.6	41.5
Malaysia	0.8	1.0	1.6	0.1	0.7	1.6	7.2	60.4	70.9
Philippines	0.5	0.3	0.6	0.1	0.3	0.6	10.3	62.8	83.8
Thailand	0.3	0.8	1.3	..	0.6	1.3	7.7	59.6	76.5
East Asia	11.0	23.8	30.7	12.0	26.7	34.8	72.5	90.3	86.6
World							66.5	80.6	68.3
Import									
China	**0.6**	**2.3**	**7.8**	**0.3**	**2.3**	**7.7**	**48.6**	**81.0**	**70.0**
Japan	6.5	7.0	0.6	3.0	5.0	3.6	30.4	57.7	49.3
Republic of Korea	0.9	2.3	2.2	0.8	2.2	2.2	59.9	74.8	59.2
Taiwan Province of China	0.6	1.7	1.4	0.6	1.7	1.4	69.7	80.1	76.2
Indonesia	0.4	0.7	0.6	0.5	0.8	0.6	80.7	83.0	57.7
Malaysia	0.5	1.0	1.1	0.5	1.0	1.1	63.9	85.6	72.3
Philippines	0.5	0.4	0.4	0.6	0.3	0.4	77.3	76.4	65.3
Thailand	0.5	1.1	1.1	0.7	1.1	1.1	85.9	84.1	68.5
East Asia	11.6	19.9	24.4	8.3	18.3	24.6	47.6	74.1	67.0
World							66.5	80.6	67.8

Source: Athukorala (2011a).

Table 4

THE SHARE OF CHINA AND JAPAN IN EAST ASIAN TRADE, 1969–2008

(Per cent)

	1969–1970	*1989–1990*	*2007–2008*
China in East Asia's non-oil trade	7	12	41
Japan in East Asia's non-oil trade	57	44	15
China in East Asia's manufacturing trade	4	11	43
Japan in East Asia's manufacturing trade	74	48	21

Source: Author's calculations, based on United Nations, *Comtrade* database.

products now account for 93 to 95 per cent of China's total exports.

Meanwhile, China has also replaced Japan as Asia's largest economy and largest trader. From the end of the 1960s to the end of the 2000s, China's share in East Asia's non-oil trade increased from 7 to 41 per cent, whereas Japan's share dropped from 57 to 15 per cent. In the manufacturing sector, China's share of East Asia's trade also vastly increased from 4 to 43 per cent, while Japan's share decreased from 74 to 21 per cent during the same period (see table 4).

III. The impact on China's technological upgrading

In the transition from the flying geese model to production sharing, China has moved from being a peripheral country to the centre of the East Asia production network, overtaking Japan as Asia's largest economy and the most important trade partner for Asian countries. This prompts the question of how much has China moved upwards on the value chain in East Asia. Can this transformation be explained by the improvement of China's industrial technology or is it simply the consequence of its export-led development strategy, which has focused on labour-intensive products? In this section, the chapter analyses the technology embodied in China's foreign trade.

There are a few methods for measuring a country's technology level of traded products. Lall (2000) developed a classification system in which manufacturing products were grouped by their technology intensiveness. According to Lall's classification, there are four types of manufactures: natural resource-based manufactures, low-tech manufactures, medium-tech manufactures and high-tech manufactures (see table 5). This system is based upon the SITC (Revision 2), in which 18 out of 161 three-digit coded products are marked as high-technology manufactures based upon available indicators of technological activity in manufacturing (Lall, 2000).

OECD has a different yet broader classification system based upon the third revision of the International Standard Industrial Classification of All Economic Activities (ISIC). In this system, manufacturing industries are grouped by their R&D intensities in production. High-technology industries include pharmaceuticals, aircraft and spacecraft, medical, precision and optical instruments, communication equipment, office, accounting and computing machinery, etc. (see table 6).

The third method is to measure a country's technology level by computing the share of parts and components (P&C) among total exports, based upon the assumption that they have higher technology contents and research and development (R&D) intensity. Aside from these three methods, some scholars have also developed a so-called export sophistication index to assess the technology level of traded products (Hausmann et al. 2006; Gang et al., 2006).

The major drawback of the OECD classification is that it does not reflect the R&D intensities in developing countries, since the calculation is based upon 12 OECD countries. Many scholars have questioned the export production sophistication index because it links technology to GDP per capita, whereby it

Table 5

LALL'S CLASSIFICATION OF MANUFACTURING INDUSTRIES BY TECHNOLOGY-INTENSIVENESS

Category	*Examples*	*SITC, rev. 2*
Natural resource-based manufactures	Prepared meats/fruits, beverages, wood products, vegetable oils, base metals (except steel), petroleum products, cement, gems, glass.	012, 014, 023, 024, 035, 037, 046, 047, 048, 056, 058, 061, 062, 073, 098, 111, 112, 122, 233, 247, 248, 251, 264, 265, 269,423, 424, 431, 621, 625, 628, 633, 634, 635, 641, 282, 288, 323, 334, 335, 411, 511, 514, 515, 516, 522, 523, 531, 532, 551, 592, 661, 662, 663, 664, 667, 681, 682, 683, 684, 685, 686, 687, 688, 689.
Low-technology manufactures	Textile fabrics, clothing, footwear, leather manufactures, travel goods pottery, simple metal structures, furniture, jewelry, toys, plastic products.	611, 612, 613, 651, 652, 653, 654, 655, 656, 657, 658, 659, 831, 842, 843, 844, 845, 846, 847, 848, 851, 642, 665, 666, 673, 674, 675, 676, 677, 679, 691, 692, 693, 694, 695, 696, 697, 699, 821, 893, 894, 895, 896, 897, 898, 899.
Medium-technology manufactures	Passenger vehicles and parts, commercial vehicles, motorcycles and parts, synthetic fibers, chemicals and paints, fertilisers, plastics, iron and steel, pipes and tubes, engines, motors, industrial machinery, pumps, ships, watches.	781, 782, 783, 784, 785, 266, 267, 512, 513, 533, 553, 554, 562, 572, 582, 583, 584, 585, 591, 598, 653, 671, 672, 678, 786, 791, 882, 711, 713, 714, 721, 722, 723, 724, 725, 726, 727, 728, 726, 727, 741, 742, 743, 744, 745, 749, 762, 763, 772, 773, 775, 793, 812, 872, 873, 884, 885, 951.
High-technology manufactures	Data processing and telecommunications equipment, television sets, transistors, turbines, power generating equipment, pharmaceuticals, aerospace, optical and instruments, cameras	716, 718 751, 752, 759, 761, 764, 771, 774, 776, 778, 524, 541, 712, 792, 871, 874, 881.

Source: Lall (2000).

assumes that rich countries always have higher export sophistication than poor countries. Therefore, in this chapter, we use the first and third methods to assess China's technology structure of export products.

Generally speaking, China's industrial technology has quickly improved during the Asian economic transformation. As shown in chart 5, the share of exports in natural resource-based manufactures maintained a relatively constant proportion from 1994 to 2011. Moreover, the share of low-technology manufactured exports decreased from 58 to 31 per cent. By contrast, the share of high-technology manufactures increased from 12 to 34 per cent and medium-technology manufactures increased from 18 to 25 per cent.

Given that natural resource-based industries do not reflect technology intensiveness and only reflect a very small part of China's exports, we can derive a clearer picture of China's technology embodied in exports when we omit such industries from our study. As shown in chart 6, the share of exports in both high and low-technology industries decreased from 1994 to 2011, while the share of exports in medium-technology industries significantly increased.

The second approach to assess China's technology upgrade and its position in East Asia's production network is to consider the trade in parts, components and accessories. Upon first glance, we find that China's importance in East Asia's trade of intermediate products has become increasingly significant. Its share of parts, components and accessories in total exports has caught up with Indonesia and Thailand, although it remains behind Malaysia, the Philippines, the Republic of Korea and Singapore (see table 7).[3]

When exploring the details of the region's trade in P&C, it is evident that China's trade with its neighbours is highly imbalanced. China reports large trade deficits with Japan, the Republic of Korea and Taiwan Province of China in the P&C trade. This shows that China is an assembly centre that heavily depends upon the import of P&C from more-developed Asian economies to support its massive exports in final goods. Chart 7 illustrates the trade balance between China and Japan, the Republic of Korea and Taiwan

Table 6

OECD CLASSIFICATION OF MANUFACTURING INDUSTRIES BASED ON R&D INTENSITY, 1999

(Per cent)

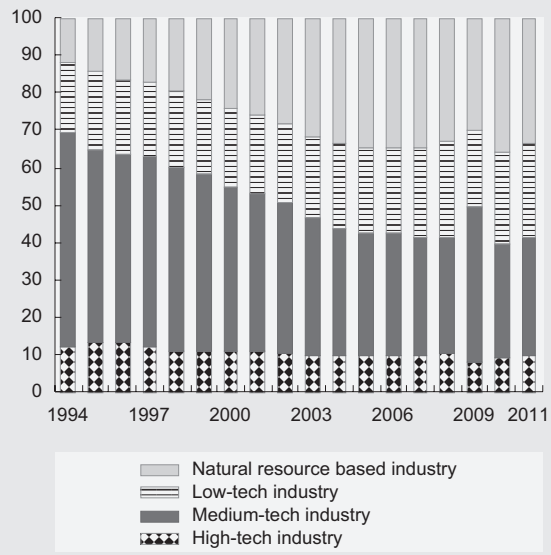
Industry name	*ISIC Rev. 3*	*R&D-intensity by production*
High-technology industries		
Pharmaceuticals	2 423	10.5
Aircraft and spacecraft	353	10.3
Medical, precision and optical instruments	33	9.7
Radio, television and communication equipment	32	7.5
Office, accounting and computing machinery	30	7.2
Medium-high-technology industries		
Electrical machinery and apparatus, not elsewhere specified (n.e.s.)	31	3.6
Motor vehicles, trailers and semi-trailers	34	3.5
Railroad and transport equipment, n.e.s.	352+ 359	3.1
Chemical and chemical products	24 (excl. 2423)	2.9
Machinery and equipment, n.e.s.	29	2.2
Medium-low-technology industries		
Building and repairing of ships and boats	351	1.0
Rubber and plastics products	25	1.0
Other non-metallic mineral products	26	0.8
Basic metals and fabricated metal products	27–28	0.6
Coke. Refined petroleum products and nuclear fuel	23	0.4
Low-technology industries		
Manufacturing, n.e.s.; recycling	36–37	0.4–0.5
Wood, pulp, paper products, printing and publishing	20–22	0.4
Food products, beverages and tobacco	25–16	0.3
Textiles, textile products, leather and footwear	17–18	0.3

Source: Author's calculations, based on OECD, *ANBERD* and *STAN* databases.

Chart 5

TECHNOLOGICAL STRUCTURE OF CHINA'S MANUFACTURED EXPORTS, INCLUDING NATURAL RESOURCE BASED INDUSTRIES,1994–2011

(Per cent)

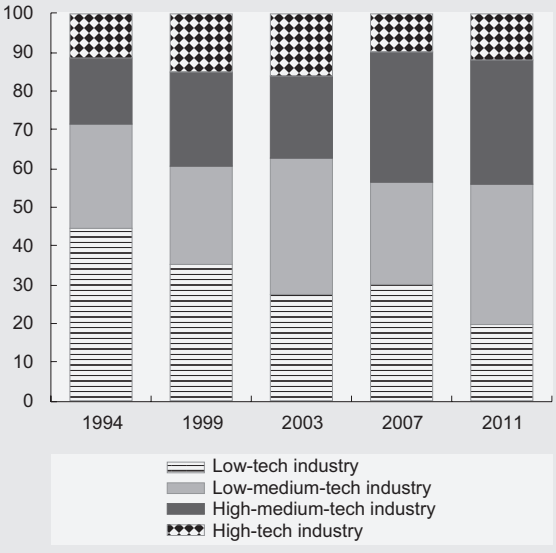


Source: Author's calculations, based on United Nations, *Comtrade* database.

Chart 6

TECHNOLOGICAL STRUCTURE OF CHINA'S MANUFACTURED EXPORTS, 1994–2011

(Per cent)



Source: Author's calculations, based on United Nations, *Comtrade* database.

Note: Selected manufactured exports exclude natural resource-based industry.

Table 7

SHARE OF PARTS, COMPONENTS AND ACCESSORIES IN TOTAL EXPORTS IN SELECTED COUNTRIES, 1994–2013

(Per cent)

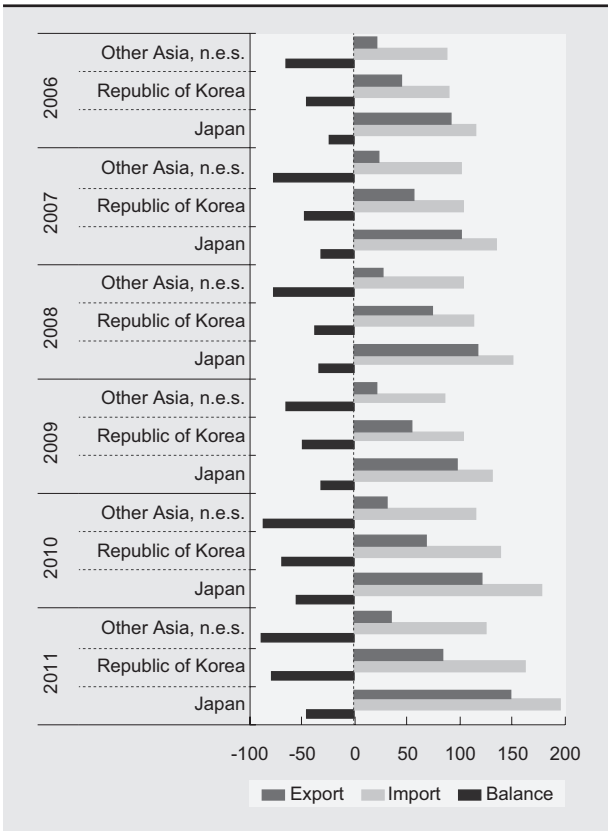
	1994	*1998*	*2002*	*2006*	*2009*	*2013*
China	4.8	7.8	12.8	14.2	9.9	10.8
India	2.4	2.4	3.4	3.7	3.2	3.5
Indonesia	2.4	3.7	6.3	4.6	3.9	4.8
Malaysia	28.0	32.5	35.9	28.8	16.1	13.2
Philippines	11.2	55.3	54.6	50.3	41.9	41.8
Republic of Korea	19.9	19.5	21.6	22.4	11.4	18.3
Singapore	29.1	34.5	38.8	40.3	16.1	20.3
Thailand	13.1	25.2	20.5	17.5	9.8	9.6
Argentina	3.5	2.6	2.8	2.4	1.9	1.7
Brazil	5.7	6.3	5.4	5.1	3.5	3.3
Mexico	14.7	15.4	16.5	15.1	11.0	10.3

Source: Author's calculations, based on United Nations, *Comtrade* database.

Chart 7

CHINA'S TRADE IN PARTS AND COMPONENTS WITH EAST ASIA, 2006–2011

(Billions of dollars)



Source: Author's calculations, based on United Nations, *Comtrade* database.

Note: Data refer to SITC 7 classification. "Other Asia, n.e.s." refers to other East Asian economies but a large proportion is from Taiwan Province of China.

Province of China, showing that China holds trade deficits with all of these countries.

Regarding China's technological upgrading, one important factor that should not be neglected is foreign content in exportation. Indeed, more than 50 per cent of China's foreign trade involves processing trade and more than 60 per cent of China's exports are conducted by FIEs. Foreign companies not only dominate China's export but also play a much more important role in high-tech sectors than in the European Union, Japan and the United States. As we can see from table 8, foreign content accounted

Table 8

FOREIGN CONTENT IN EXPORTS, SELECTED COUNTRIES AND COUNTRY GROUP, 1995–2005

(Per cent)

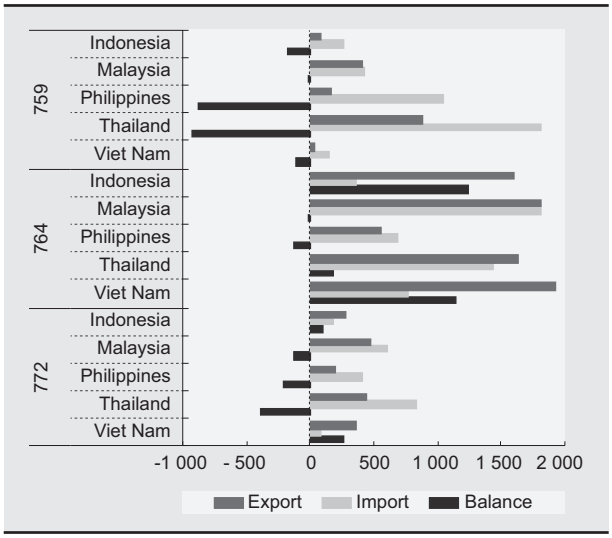
		In gross export	*In high-tech sectors*
China	1995	15.5	20.1
	2005	27.4	48.5
Japan	1995	8.2	10.0
	2005	15.2	21.5
United States	1995	9.5	16.6
	2005	12.3	17.4
European Union	1995	20.8	24.1
	2005	27.8	31.4

Source: Author's calculations, based on IMF database.

Chart 8

CHINA'S TRADE IN HIGH-TECH PARTS AND COMPONENTS WITH SELECTED ASEAN COUNTRIES, BY SITC CODE, 2011

(Millions of dollars)



Source: Author's calculations, based on United Nations, *Comtrade* database.

Note: Since the trade value of SITC 77689 is too small, it is taken off of the chart.

for 48.5 per cent of China's high-tech export in 2005. Although China's high-technology product exports have generally increased, the extent to which this reflects Chinese innovation and technology remains uncertain. If we look more closely at the domestic content in China's export, we can see that FIEs operating in China created almost 45 per cent of the domestic content in Chinese exports, whereas processing Chinese-owned enterprises only contributed by less than 5 per cent (Ma et al., 2014).

Trade between China and ASEAN-4 in high-technology products is more diversified, whereby China holds a trade surplus in P&C of office equipment, telecommunications and transport equipment, but trade deficits in semi-conductors. Within ASEAN-4, China holds a trade surplus with Indonesia and Viet Nam, but has a deficit with Malaysia, the Philippines and Thailand in P&C (see chart 8). Accordingly, China has caught up with some of the ASEAN countries, although its innovation capability and manufacturing technology remain far behind Japan and Asian NIEs, and even behind Malaysia and the Philippines in some industries.

IV. Conclusion

In recent decades, production sharing has become the new feature of East Asia's production network. Manufacture sectors in East Asian economies are highly integrated according to the vertical intra-industry division of labour, whereby regional trade is also fragmented and characterized as intra-industry trade. Compared to other parts of the world, trade in parts and component accounts for a much larger share of East Asia's total trade, particularly in manufacturing sectors. Accordingly, this chapter analyses China's position in East Asia's production network and how it influences China's industrial and technological upgrading.

This chapter has found that China has moved from being a peripheral country to the centre of the East Asia's production network. China has replaced Japan as the largest economy and most important trade partner of the region. China is now the largest market for almost all East Asian economies, with the share of China's export of manufacturing goods in East Asia having increased from 4 to 43 per cent, while Japan's share dropped from 74 to 21 per cent. A great proportion of the Republic of Korea, Japan and Taiwan Province of China's high-technology P&C are exported to China, while a large percentage of their consumer goods are imported from China. For developing East and Southeast Asian countries, China is a major importer for raw materials and a major exporter for final products.

China has improved its technology of manufacturing products thanks to a massive inflow of Asian FDI. The shares of high-tech and medium-high-technology exports in China's total exports have constantly increased, while the share of exports in low-technology and medium-low-technology products has steadily declined since 1990s. According to Chinese statistics, the export of high-technology products accounts for more than one-third of China's total export value.

While there is a technology convergence between China and ASEAN-4, the gaps between China and more-developed Asian countries remain fairly large and noticeable. Considering that 50 to 60 per cent of China's foreign trade is conducted by FIEs, we can

conclude that China is still at the lower end of the Asian value chain. In high-technology sectors, China depends upon the import of P&C from Japan, the Republic of Korea and Taiwan Province of China. Despite its large trade value, China is still not a technology supplier but rather a demander.

Notes

1 International production sharing is defined here as the internationalization of a manufacturing process in which several countries/economies participate in different stages of a specific good's production. The process holds considerable economic importance since it allows stages of production to be located where they can be undertaken most efficiently. If production sharing is increasing in relative importance, this implies that countries are becoming more economically interdependent.

2 Many scholars estimate this by calculating the proportion of so-called processing trade in total export without a clear definition of what is processing trade.

3 Table 7 also shows that the Philippines' trade in parts and components is fairly high, even higher than the Republic of Korea and Singapore. This is possible because the Philippines has the well-educated, English-speaking skilled workers, which attract many high-technology companies of Japan and the Republic of Korea relocating their manufacture for parts, components and accessories to the Philippines. The difference between China and the Philippines is that China imports vast quantities of P&C, whereas the Philippines exports most of the parts and components they make.

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