International Production Networks in East Asia's Electronics Industry

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ABSTRACT

This study investigated the East Asia's electronic production network and its evolution from 1990 to 2010. A network analysis is used to identify the major trade links for both parts and components and final products, and changes in roles, trading partners and network patterns for the years 1990, 1995, 2000, 2005 and 2010. The results suggested that the role of Japan and the Korea in the 1990s expanded to becoming exporters of electronic parts and components and final electronics as well as importers of final electronics. In contrast, the role of Malaysia and Thailand seems to have been confined to being exporter of both electronic parts and components and final electronics. Meanwhile, some countries such as Indonesia, the Philippines and China experienced erratic changes in their role, while that of Singapore remains unchanged. The results also indicate that the relocation of Japanese and Korean FDI to lower-labour-cost countries such as China in the 2000s has forced some ASEAN countries to each upgrade their electronics industry and emerged as a main supplier of electronic parts and components for their neighbouring countries. These circumstances, in turn, have changed the pattern of hierarchy within the international electronics production network in the ASEAN region.

Keywords: International Production Networks, Electronic Industry, East Asia, Electronic Parts and Components.

1. INTRODUCTION

The development of global production networks in electronics since the 1960s has proceeded in stages. In the early stages, this industry has globalised its production, from North America, Europe and later Japan to the NIEs and ASEAN-4 countries (Dicken, 2007; Scott, 1987). During that period, leading firms from those developed countries began to establish production facilities in several Southeast Asian countries, starting with Singapore and then later in Malaysia and Thailand with the aim of taking advantage of the cheaper labour and infrastructure costs. Nonetheless, during this period East Asian countries (except Japan) played only a minor role in the electronics industry while the centre of the global production of electronics products remained in the United States, Europe, and Japan (Gangnes and Van Assche, 2010a).

In the second half of the 1980s, the competitiveness of the East Asian countries particularly in sectors such as semiconductor, consumer electronics and personal

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computer greatly improved and the region now account for a large proportion of the total world trade in many electronics sectors. According to Ganges and Van Assche (2010b), the electronics sector of many East Asian countries experienced a compound annual growth of 20 to 30 percent or more between 1985 and 1995. Since then, this rapid growth has continued and in 2005, New Asian Industrial Economies (NAIEs), ASEAN-4 and China together accounted for 43 percent of world electronics production. Among the reasons behind this development is the decision of American and Japanese firms to shift some stages of their production to other countries in response to the changing technological and competitive environment (Borrus et al., 2000; Lowe and Kenney, 1999). This fragmentation in turn led to the rise in a number of specialized component suppliers, manufacturing service providers, and modular manufacturers, as well as developing production and trade relationships between and among East Asian countries.

The aim of this study is to investigate electronics production in East Asia and account for how this has evolved from 1990 to 2010 to become a hub for global production. First, the major role of each country in East Asia's international electronics production chain is explored by examining their Export Intensity Index (EII) and Import Intensity Index (III) in terms of trade in electronics parts and components and final goods. Second, each country's main trading partners are identified using their Export Share Index (ESI) and Import Share Index (ISI) to illustrate the trade network and dependences between countries. Third, the evolution of this trade network is investigated in terms of how countries roles, trading partners and network patterns have changed for the years 1990, 1995, 2000, 2005 and 2010.

2. DATA

In this study, we used data from the UN Comtrade and chose SITC revision 2 to classify the commodities' group. We opted for SITC revision 2 as it provides a detailed commodity classification to distinguish traded parts and components from final goods, particularly in the machinery and transport sector. Table 1 depicts data for both electronic parts and components, and final electronics that we used in this study. To distinguish electronic parts and components from final electronics, we adapted the work by Lall et al. (2004). Items termed "parts and accessories" by SITC are counted as parts and components, while others are treated as final goods. Nonetheless, unlike Lall (2004), we did not include semiconductors in the final product list as they are generic components used to produce many final electric and electronics products. In addition, we included television image and sound recorders or reproducers, nes. (SITC 76381), dictating machines and other sound recorders and reproducers, nes (SITC 76388), electrical line telephonic and telegraphic apparatus (SITC 7641) and microphones, loud-speakers, and audio-frequency electric amplifiers (SITC 7642) in our final electronics list. Also included in our electronic parts and components list were: parts, nes of the apparatus, equipment falling within heading 7641 (SITC 76491); and parts, nes of the apparatus, equipment falling within heading 7642 (SITC 76492).

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The main focus of our study is the following East Asian countries: Japan, China, Republic of Korea, and ASEAN (i.e., Thailand, Indonesia, Malaysia, the Philippines, Singapore and Vietnam). Japan and the Republic of Korea are Asia's leading electronics manufacturers, while China has emerged as the world's largest producers of electronics products in 2005. In Asia's southeast region, Singapore, Malaysia, Thailand and the Philippines is the dominant global manufacturing base of the electronics industry particularly for assembly. Even though the growth and development of electronics industry in Vietnam are not as drastic as those discussed above, their automobile industry is currently experiencing steady growth. The UN Comtrade system data does not cover Taiwan as it is not a member of the UN. Therefore, we do not include Taiwan in our study due to a lack of data. To see the impact of East Asia's automobile industry on other regions and vice versa, we include North American Free Trade Agreement (NAFTA), European Union (EU) and the rest of the world (ROW) in our analysis.

3. METHODOLOGY

In this study, we conduct two types of analyses, namely country-level analysis and a bilateral network analysis. The former analysis is used to examine roles played by each country as well as its major trading partners. In this analysis, we identify the important linkages for either the source or destination country by employing a two-step procedure. First, we attempt to identify whether total trade in terms of the export or import of electronic parts and components and/or export or import of final electronics are important for a particular country. Second, if it is considered an important trade flow then we attempt to identify the major countries where this linkage exists. Consequently, information from the above procedure will be presented in the quadrant diagrams at the country level analysis. Finally, we put all the countries together to identify countries' position in the East Asia's electronics production chains.

3.1 Identifying Important Trade Flows

There are four possible roles which could be played by each country: they might be an important exporter of electronic parts and components; an important importer of electronic parts and components; an important exporter of final electronics or an important importer of final electronics. To identify which trade role is important for a country, we developed Export Intensity Index (EII) and Import Intensity Index (III) for both electronic parts and components and final electronics respectively. The EII measures the country A's total exports of electronic parts and components (final electronics) in terms of its total trade in electronics industry, while the III measures the country A's total imports of electronic parts and components (final electronics) in terms of its total trade in electronics industry. These four indices sum to one provides indication of trade structure of import and export of parts and components as well as import and export of final electronics. Formulae for such indices are as follows:

EII for electronic parts and components: $\frac{\sum X^{A}_{P\&C}}{T^{A}_{P\&C} + T^{A}_{FG}}(100)$

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III for electronic parts and components: $\frac{\sum M^{A}_{P\&C}}{T^{A}_{P\&C}+T^{A}_{FG}}(100)$

EII for final electronics: $\frac{\sum X^{A}_{FG}}{T^{A}_{P\&C}+T^{A}_{FG}}(100)$

III for final electronics: $\frac{\sum M^{A}_{FG}}{T^{A}_{P\&C}+T^{A}_{FG}}(100)$

where,

$X^{A}_{P\&C}$ = country A's export of electronic parts and components to its partners.

$M^{A}_{P\&C}$ = country A's import of electronic parts and components from its partners.

X^{A}_{FG} = country A's total export of final electronics to its partners.

M^{A}_{FG} = country A's total import of final electronics from its partners.

$T^{A}_{P\&C} = \sum X^{A}_{P\&C} + \sum M^{A}_{P\&C}$

$T^{A}_{FG} = \sum X^{A}_{FG} + \sum M^{A}_{FG}$

3.2 Identifying Important Partners

To identify the important import partners and the important export partners for each country we developed Export Share Index (ESI) and Import Share index (ISI) for both electronic parts and components, and final electronics respectively. The ESI measures the country A's export of electronic parts and components (final electronics) from country B in terms of its export of electronic parts and components (final electronics) from the world, while the ISI measures the country A's import of electronic parts and components (final electronics) from country B in terms of its import of electronic parts and components (final electronics) from the world. These indices would differentiate the important partners from other minor partners using the following formulae:

ESI for electronic parts and components= $\frac{X^{A,B}_{P\&C}}{X^{A,W}_{P\&C}}(100)$

ESI for final electronics = $\frac{X^{A,B}_{FG}}{X^{A,W}_{FG}}(100)$

ISI for electronic parts and components = $\frac{M^{A,B}_{P\&C}}{M^{A,W}_{P\&C}}(100)$

ISI for final electronics = $\frac{M^{A,B}_{FG}}{M^{A,W}_{FG}}(100)$

where,

$X^{A,B}_{P\&C}$ = country A's exports of electronic parts and components to country B

$M^{A,B}_{P\&C}$ = country A's imports of electronic parts and components from country B

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$X_{P\&C}^{A,W}$ = country A's total export of electronic parts and components
$X_{FG}^{A,B}$ = country A's exports of final electronics to country B
$M_{FG}^{A,B}$ = country A's imports of final electronics to country B
$X_{FG}^{A,W}$ = country A's total export of final electronics to the world

In identifying both important trade flows and important partners we have explored a number of alternative cut offs before picking 15 percent on basis that seemed to capture major linkages without over cluttering diagrams. A sensitivity analysis of 12 and 18 percent were also implemented to explore the robustness of conclusions to what is essentially an arbitrary choice of cut off.

3.3 The Quadrant Diagrams

The important role played by each country as well as their important trading partners between the period of 1990 and 2010 will be presented in the form of quadrant diagrams. The first quadrant in each quadrant diagram represents the area of exports of electronic parts and components. This quadrant provides information such as the value of total export of electronic parts and components abroad (total value of the 1st quadrant), the share of total export of electronic parts and components abroad in terms of the total electronic trade (in percentage) and the major destinations for electronic parts and components. The second quadrant in each diagram represents the area of imports of electronic parts and components. This quadrant also provides information such as the value of total import of electronic parts and components (total value of the 2nd quadrant), the share of total import of electronic parts and components in terms of the total electronic trade (in percentage) and the major sources of electronic parts and components. The area for import of final electronics is represented by the third quadrant in each diagram. This quadrant provides information such as the value of total import of final electronics worldwide, the share of total import of final electronics in terms of the total electronic trade (in percentage), and the most important countries that export final electronics to a country's market. The fourth quadrant in each figure is devoted to the area of exports of final electronics. As with other quadrants, it also provides information such as the value of total export of final electronics abroad, the share of total export of final electronics abroad in terms of the total electronic trade (in percentage), and the major importers of final electronics.

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Table 1: Final Goods and P&C in Electronics Industry (SITC Rev. 2)

Main Product	Code	Final Goods	Code	Parts and Components
Electronic Equipment	75111	Typewriters with ordinary characters, electric	75911	Parts, nes of and accessories for typewriters of heading 7511
	75112	Typewriters with ordinary characters, non-electric	75915	Parts, accessories for machines of headings 75181, 75188 and 75118
	75118	Typewriters, nes; cheque-writing machines	75919	Parts, nes of and accessories for photo and thermo-coping machines
	75121	Calculating machines	7599	Parts, nes of and accessories for machines of headings 7512 and 752
	75122	Accounting machines		
	75122	Accounting machines		
	75123	Cash registers		
	75128	Postage-franking, tickets-issuing and similar machines		
	75181	Duplicating machine, hectograph or stencil		
	75182	Photo-copying and thermo-copying apparatus		
	75188	Other office machines, nes		
IT Products	7521	Analogue and hybrid data processing machines	7599	Parts, nes of and accessories for machines of headings 7512 and 752
	7522	Complete digital data processing machines		
	7523	Complete digital central processing units; digital processors		
	7524	Digital central storage units, separately consigned		
	7525	Peripheral units, including control and adapting units		
	7528	Off-line data processing equipment, nes		
Consumer Electronics and Telecommunication Products	7611	Television receivers, colour	76491	Parts, nes of the apparatus falling within heading 7641
	7612	Television receivers, monochrome	76492	Parts, nes of the apparatus, equipment falling within heading 7642
	7621	Radio receivers for motor-vehicles	76493	Parts, nes of the apparatus of the heading 761, 762, 7643 and 7648
	7622	Portable radio receivers	76499	Parts, nes of and accessories for apparatus falling in heading 763
	7628	Other radio receivers		
	76311	Gramophones, electric, coin-operated		
	76318	Other electric gramophones and record players		
	76381	Television image and sound recorders or reproducers, nes.		
	76388	Dictating machines and other sound recorders and reproducers, nes		
	7641	Electrical line telephonic and telegraphic apparatus		
	7642	Microphones; load-speakers; audio-frequency electric amplifiers		
	7643	Television, radio-broadcasting; transmitters, etc		
	76481	Radiotelephonic or radiotelegraphic receivers		
	76482	Television cameras		
	76483	Radio navigational aid apparatus, radar apparatus etc		

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To decide whether or not a quadrant is important, we consider the value of share of total quadrant in terms of the total electronic trade. If the share value is greater than the 15 percent threshold, we assumed that the quadrant is important. In this respect, we used black bold arrows to indicate that the quadrant is important. On the other hand, if any quadrants are not important they are represented by a white arrow. Meanwhile, in order to determine whether or not a link between a country and its partners is important in any quadrant, we need to consider the value of share of exports or imports (depending on which quadrant we are referring to) between that country and its partner compared with the total quadrant. If the value of share is greater than the 15 percent threshold, we may assume that the link between the country and such a partner in the quadrant is important.

3.4 International Production Chain and Expected Trade Relationship

In this section, we further develop a method to examine the pattern of linkages in the electronics industry. This pattern of linkages would help us identify the position of each country in the international production network in this industry, as well as the development of this network over the past 20 years. In order to examine the pattern of linkages, we analyse the bilateral relationships between each country and its trading partners. In these relationships, we envisaged eight possible types of relationship for both parts and components and final goods based on the four conditions outlined below (see Piana, 2006)[1]:

a. For A's trading partner, A is a major export destination (market)
b. For A's trading partner, A is a major import source (supplier)
c. For A, its trading partner is a major export destination (market)
d. For A, its trading partner is a major import source (supplier)

The value of one will be given to each condition if the condition is true (i.e., the quadrant is considered important and the value of exports or imports for a particular country is greater than the 15 percent threshold) or otherwise zero. Table 2 describes the types of relationship that might occur between countries.

Table 2: Possible Types of Relationship between Countries

Binary code	Description
0001	Country A relies upon its partner as an import source. This link is only important for one party (i.e., country A, but not its partner).
0100	Its partner relies upon country A as an import source. This link is only important for one party (i.e., its partner, but not country A).
0010	Country A relies upon its partner as a market destination. This link is only important for one party (i.e., country A, but not its partner).
1000	Its partner relies upon country A as a market destination. This link is only important for one party (i.e., its partner, but not country A).

[1]Piana (2006) applied the above methodology to the countries' total trade data to identify the world trade structure. Our study, however, differs from Piana (2006) as even though we used a similar methodology, we focus on a specific industry (i.e., electronic industry) and divide the industry into two markets, namely, electronic parts and components market, and final electronics which helps us describe the production chain and changes in the production chain within this industry.

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0011	A country relies upon its partner as both import source and market. This link is only important for one party (i.e., country A but not its partner).
1100	Its partner relies upon country A as both import source and market. This link is only important for one party (i.e., its partner but not country A).
0110	A country relies upon its partner as a market destination, while its partner relies on her as an import source. This link is important for both parties.
1001	Its partner relies upon country A as a market destination, while country A relies on its partner as an import source. This link is important for both parties.
0101	Two countries rely upon each other as import sources. This link is important for both parties.
1010	Two countries rely upon each other as import markets. This link is important for both parties.
1111	Two countries rely upon each other in terms of both import source and market. This link is important for both parties.
0111	A country relies upon its partner in terms of both import source and market, while its partner relies on her as an import source. This link is important for both parties.
1101	Its partner relies upon country A in terms of both import source and market, while country A relies on its partner as an import source. This link is important for both parties.
1011	A country relies upon its partner in terms of both import source and market, while its partner relies on her as a market destination. This link is important for both parties.
1110	Its partner relies upon country A in terms of both import source and market, while country A relies on its partner as a market destination. This link is important for both parties.

Accordingly, we define country A as:

- a “top” country if it is an export country where other countries rely on its exports but it is not dependent on any one of its partners (as shown by codes PC0100 and FG0100) or other countries rely on its exports and it is also reliant on these partners as important markets (shown by codes PC0110 and FG0110) or it relies on other countries markets (shown by codes PC0010 and FG0010) or other countries rely on her for their source and market of electronic parts and components (shown by code PC1100) or other countries rely on her for their source and market of electronic parts and components and it is also reliant on these partners as important sources (shown by code PC1101) or other countries rely on her for their source and market of electronic parts and components and it is also reliant on these partners as important markets (shown by code PC1110)[2]. Since in electronics there is a possibility for a “top” country to import final electronics from middle countries, we need to consider those codes in the FG column in Table 4.

[2] The reciprocal relationship (shown by codes PC1100, PC1101 and PC1110) indicate that a top country exported electronic parts and components to its partner(s) and then re-imported those products for further process. In this relationship, the top country is less care on its partner(s).

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We further break up the "top" into "basic top" and "advanced top". The "basic top" refers to a country which only exports final electronics abroad and it should not have any code(s) in the FG column in Table 3. The "advanced top" refers to a country which exports both electronic parts and components, and final electronics and it should have some combination of codes in both the PC and FG columns in Table 3. We then break up the "advanced top" into "simple-advanced top" and "complex-advanced top". The "simple-advanced top" refers to an advanced top country which exports its parts and components to the "bottom" countries with a simply a one-way flow of parts and components. Meanwhile the "complex-advanced top" refers to an advanced top country which exports its parts and components to the "middle" country where that middle country at least re-exporting the parts and components to her.

Table 3: Codes for a "Top" Country

PC0100	FG0100
PC0110	FG0110
PC0010	FG0010
PC1100	
PC1101	
PC1110	

- a "middle" country if it exports parts and components to a top country, or it imports parts and components from a top country and also either exports part and components or exports final goods to other countries as this suggests that the country is internationally competitive in at least some part of the production process. We further break up "middle" into "simple middle" and "advance middle". Both "simple middle" and "advance middle" countries import parts and components from a top country and then either re-exports the products to the top country or exports them to other countries. The only difference between the two is that the "simple middle" country does not export final goods to any country, but the "advanced middle" do. To be a "simple middle" a country must have at least one code in the first PC column and one code in the second PC column with the absence of any code(s) in the FG column in Table 4, while to be an "advanced middle" a country must have at least one code in the first PC column and at least one code in the FG column in Table 4).

Table 4: Codes for Country a "Middle" Country

PC0001	PC0100	FG0100
PC1001	PC0110	FG0110
PC1000	PC0010	FG0010
PC0011	PC0011	
PC1101	PC0111	
PC1110	PC1011	

- a "bottom" country if it is an importer with at least one of the codes in Table 5 and no exports of either parts and components or final goods which are important to it or other countries (shown by the absence of any of the code(s) that appear in Table 3). We further consider the country as "bottom simple" if it only imports final goods (the country has only code(s) in the FG column), and as "bottom advanced" if it also

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imports parts and components (codes in the PC column as well) as this suggest some domestic assembly.

Table 5: Codes for Country "Bottom"

PC0001	FG0001
PC1001	FG1001
PC1000	FG1000
PC0011	
PC0111	
PC1011	

4. RESULTS AND DISCUSSION

4.1 Country-level analysis

Figures 1-9 illustrates East Asian countries' position in electronic parts and components trade as well as final electronics trade between 1990 and 2010. Based figure 1, we can see that the role of Japan was consistently as an important exporter of both electronic parts and components and final electronics. However, since 1995 its role as an importer of final electronics began to be important. For example, in 2010, Japan exported about US$ 19.3 billion final electronics and US$ 10.3 billion electronic parts and components worldwide. At the same time its import of final electronics from abroad was around US$ 30.7 billion. These figures are well over 15 percent from its total trade for electronics products. In that year, Japan only imported US$ 5.8 billion electronic parts and components from around the world and this figure is smaller than 15 percent from its total trade for electronics products. The important markets of Japanese final electronics were NAFTA (1990, 1995, 2000, 2005 and 2010), EU (1990, 1995, 2000 and 2005), ROW (2005 and 2010) and China (2005 and 2010), while the important sources of Japanese final electronics were NAFTA (1995 and 2000), Singapore (1995), Malaysia (2000) and China (2005 and 2010). In terms of the electronic parts and components, most of these products went to NAFTA (1990, 1995, 2000, 2005 and 2010), EU (1990, 1995, 2000 and 2005), ROW (2005 and 2010) and China (2005 and 2010).

The role of Japan as an important supplier of electronic products seems to have a close relationship with the development of Japanese electronics in the late 1980s. A sudden and dramatic appreciation of the yen following the Plaza Accord, rising trade protectionism in the USA and European countries against Japanese firms, increasing domestic labour shortages, as well as FDI promotion policies in Asian developing countries forced Japan to shift its production facilities overseas. Most of the Japanese FDI in Asia is in the electronics industry.[3] According to Belderbos and Zou (2006), ASEAN-4 (except during the 1997 financial crisis) and China have received continuous and significant growth of Japanese manufacturing FDI between 1991 and 2000[4]. In its operation, Japanese electronics affiliates in Asian countries are relying heavily on components or materials from Japan or those acquired from other local Japanese affiliates. In addition, Japanese electronics affiliates,

[3] According to Ernst (1997), nearly half of the total increase in Japanese FDI to Asia between 1985 and 1993 is in the electronics industry.

[4] ASEAN-4 comprises Indonesia, Malaysia, the Philippines, and Thailand.

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particularly those in the ASEAN region, have also often been assigned the role of export bases, with their final products mainly sold in third countries or re-exported to Japan.

Figure 1: Japanese Trade of Electronic Parts and Components and Final Electronics

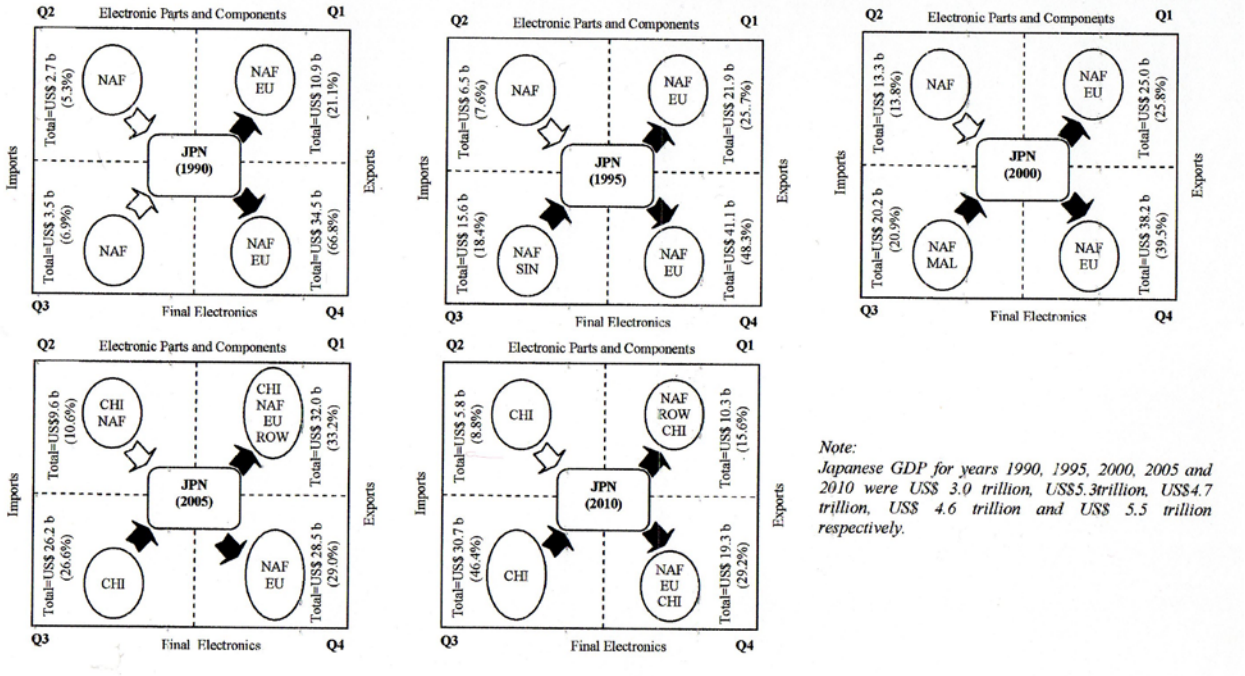

Figure 2 illustrates Korean's position in electronic parts and components trade as well as final electronics trade between 1990 and 2010. This figure shows that between 1995 and 2010 the Republic of Korea consistently played a role as an important exporter for electronic parts, components and final electronics. As in the Japanese case, since 1995 the Republic of Korea also began to be an important importer of final electronics. In 2010, for example, the Korean total export in terms of its total trade of electronics products for both electronics parts and components, and final electronics respectively were greater than 30 percent. Meanwhile, its import of final electronics in terms of total trade of electronics products in that year was 22 percent. On the other hand, the Korean imports of electronic parts and components in terms of its total trade of electronics products in that year, however, were less than 5 percent. The important markets of Korean final electronics were NAFTA (1990, 1995, 2000, 2005 and 2010), EU (1995, 2000, 2005 and 2010), ROW (2005), China (2005 and 2010) and Japan (1990 and 2000), while the important sources of Korean final electronics were NAFTA (1990, 1995, 2000 and 2005), Japan (1990 and 1995), Singapore (1995 and 2000) and China (2005 and 2010). In terms of the electronic parts and components, most of these products went to NAFTA (1990, 1995, 2000, 2005 and 2010), EU (1995, 2000, 2005 and 2010), ROW (2005) and China (2005 and 2010).

Korea has become an important exporter of electronics products due to various factors such as government policies, the role of *Chaebols* and universities. The Korean government has provided legislative support to assist the high-tech industry towards growth through low-interest loan, tax intensives, duty-free import of selected capital products, and national banking regulation. Direct financial support was also provided to universities, public and

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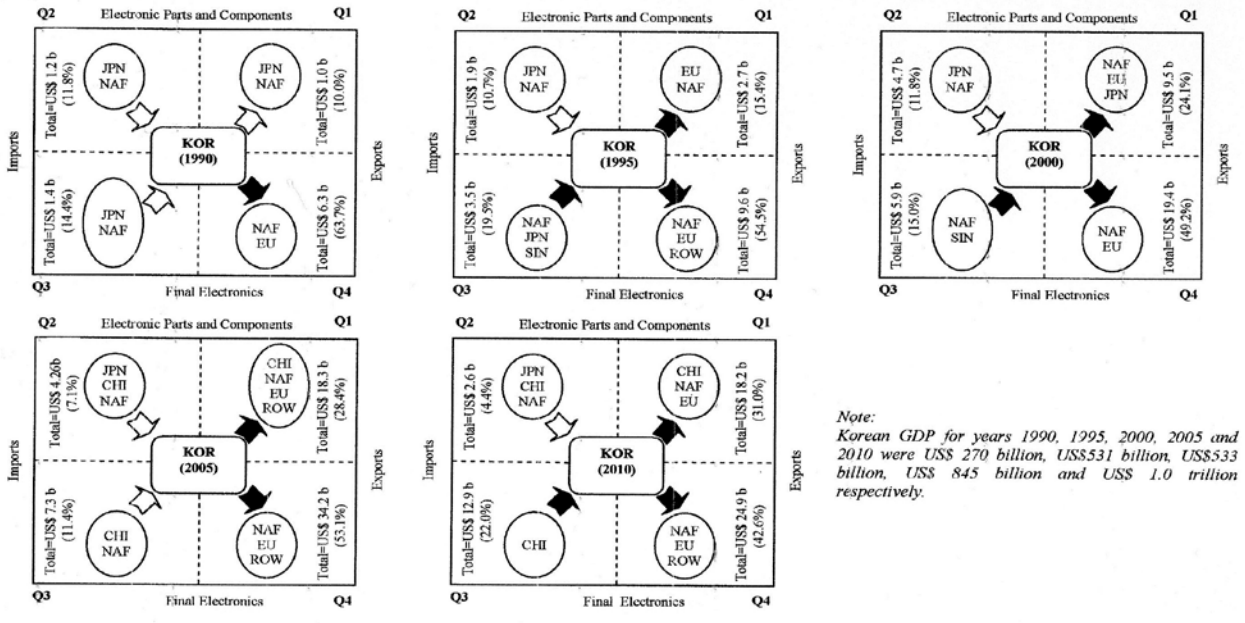
non-profit institutes and other educational institutions to promote education and R&D for the high-tech industry. Besides, the Korean government also provided fund for infrastructure development such as highways, transportation systems, construction of a “science park”, and rapid dissemination of Internet-type services. Meanwhile, the government also made efforts to encourage the establishment of small and medium firms, including the establishment of institutes such as the Korean Electronics Technology Institutes aimed at assisting small and new high-tech industries in product development, augmenting their tool bases, and providing other services to help them get off the ground. The success of the four most prominent Chaebol, i.e. Sumsung, LG, Hyundai, and Daewoo, has greatly contributed to the development of Korean electronic product exports. 1n 1996, Sumsung has become the world’s biggest DRAM supplier, while Hyundai and LG were in the second and sixth place, respectively. They are very successful in Europe where Sumsung’s sales were more than 1 billion in 1994 (Pecht et al., 1997). Meanwhile, both public and private universities also play a role by offering strong programs in support of the electronics industry.

China's electronics industry has been growing rapidly since the 1990s and the country has become the largest producer of electronic products in the world in 2005. Figure 3 illustrates China’s position in electronic parts and components trade as well as final electronics trade between 1990 and 2010. Based on these figures, it is appear that China was an important exporter for final electronics in all the year under study. The growth of exports of its final electronics increased dramatically year by year. For example, between 1990 and 2010 Chinese export of final electronics increased from US$3 billion to US$298 billion. By 2010 exports of final electronics account for more than 75 percent from its total trade of electronics products and the main market for these products were NAFTA, EU and ROW.

Figure 2: Korean Trade of Auto Parts and Components and Automobiles



Note:
Korean GDP for years 1990, 1995, 2000, 2005 and 2010 were US$ 270 billion, US$531 billion, US$533 billion, US$ 845 billion and US$ 1.0 trillion respectively.

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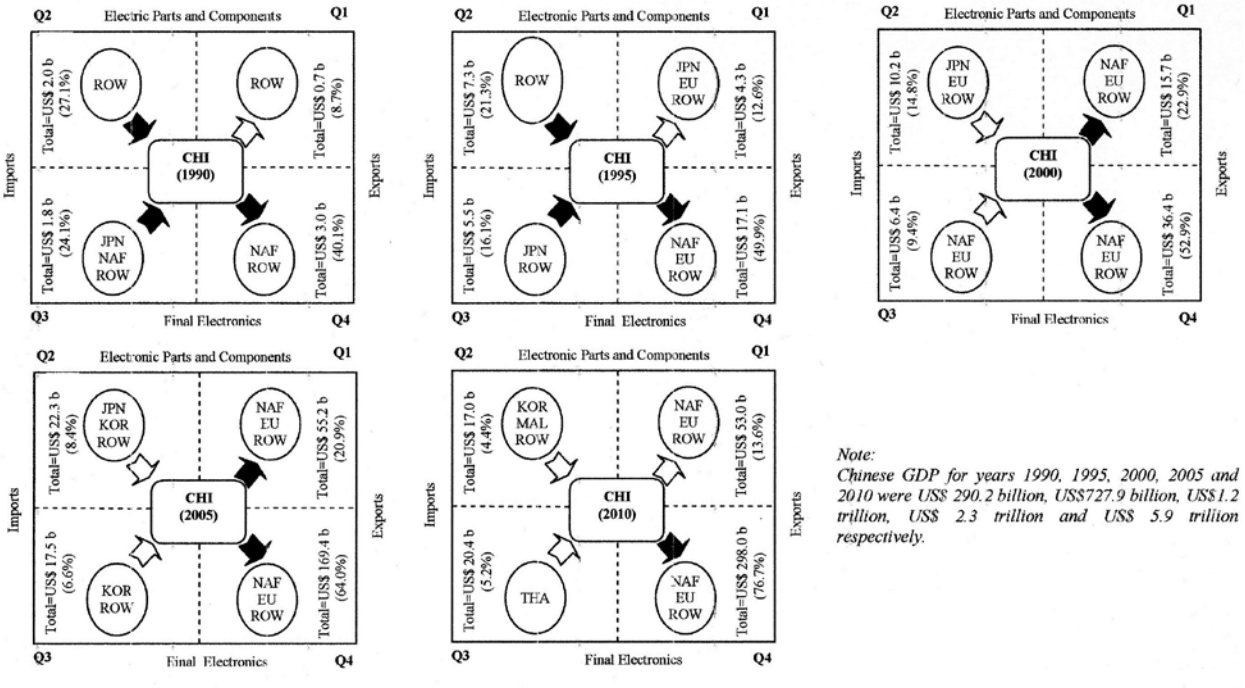
The government has played an active role in developing the Chinese electronics industry. Apart from the establishment of the Ministry of Electronics Industry to supervise the industry, various policy instruments have been adopted to support and monitor the industry. Examples of such instruments are the following:

1. Strategy of Technology Transfer in Exchange for Domestic Market Access (TTEDM) – under this strategy, multinational corporations are offered access to the domestic market in exchange for advanced technology transfer from those firms. In 1990, a large amount of foreign capital investment came into China as a result of the huge potential of the Chinese market and the success of the TTEDM strategy.
2. R&D funding – Electronics Industry Development Fund (EIDF) was set up in the late 1980s to support the development of the electronics industry. At its inception, EIDF has served to support R&D as well as production of four key electronic products (viz. integrated circuits, computers, software, and program-controlled switching devices).
3. FDI and trade policy – the Chinese government has encouraged both export-oriented FDI and export-substitutive FDI. Among steps taken by the government is increasing the number of encouraged items and reducing the number of restricted items of electronic projects in *various versions of Industrial Guidance of Foreign Investment* to provide wider access to foreign capital.[5]
4. A High Technology Zone (HTDZ) policy was developed in 1988 to deliver incentives for high technology industries.

Figure 3: Chinese Trade of Electronic Parts and Components and Final Electronics



Thailand's position in electronic parts and components trade as well as final electronics trade between 1990 and 2010 has been illustrated in Figure 4. Based on these figures, we can see

[5] Between 1997 and 2005, the number of encouraged items increased from 20 to 45, while the number of restricted items decreased from 9 to 1.

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that Thailand was an important exporter for electronic parts, components and final goods in all years under study. In addition, its role as importer of electronic parts and components is also important. Between 1990 and 2010 Thailand's export of both electronic parts and components, and final electronics in terms of its total trade of electronics products were more than 16 percent. Meanwhile, Thailand's import of electronic parts and components in terms of total trade of electronics products almost each was greater than 20 percent. The major markets of Thai electronic parts and components were Singapore (1990, 1995, 2000 and 2005), Malaysia (2010), (Japan (1990 and 2000), EU (1990 and 2010), NAFTA (1995 and 2005) and China (2005 and 2010), while the major market for its final electronics were NAFTA (1990, 1995, 2000, 2005 and 2010), EU (1990, 1995, 2000, 2005 and 2010), Japan (1995 and 2000), Singapore (1990 and 1995) and China (2005 and 2010). Meanwhile, most of its electronic parts and components were imported from Japan (1990, 1995, 2000 and 2010), Singapore (1990, 2000 and 2005), Malaysia (1995, 2000, 2005 and 2010) and China (2005 and 2010).

The role of the government is an important factor for the development of the electronics industry in Thailand. Since the country's policy shift from "import-substitution" to "export-oriented", efforts have been made to promote trade and investment. For instance, to attract investors into Thailand, the government has provided certain incentives such as: low tariffs for imports needed to produce electronic export unit; exemption from and/or reduction of import duties, corporate income and other income-related taxes; credit assistance; loosening of controls on foreign ownership of firms; and provision of infrastructure support and services (UNCTAD, 2005). These various incentives, coupled with the availability of a cheap and skilled labour force, have attracted producers of electronic products such as Seagate Technology, the Japanese Minebea Group and Hana Semiconductor to set up production facilities in Thailand. The involvement of foreign firms in Thailand would in turn result in an increase in the production of electronic products as well as diversifying the export product range.

Electronics components, consumer electronics and computing are the biggest contributor to Indonesia's electronics industry, where these three group of products accounted for 87 percent of output in 2002 (Santiago, 2007). Indonesian position in electronic parts and components trade as well as final electronics trade between 1990 and 2010 has been illustrated in Figure 5. Based on these figures, it is appear that Indonesia consistently became an important exporter for final electronics since 1995 and became an important exporter of electronics since 2000. Since 1995 exports of final electronics in terms of total trade of electronics products was well over 30 percent. Likewise, since 2000 export of electronic parts and components in terms of total trade of electronics products in many years under study was greater than 15 percent. Indonesia's role as important importer of electronic parts, components and final electronics is also significant in the most years under study. Most of Indonesian final electronics was exported to NAFTA and EU, while most of its electronic parts and components went to Japan and Singapore. Meanwhile, Japan, Republic of Korea, Singapore, NAFTA and EU were among the important suppliers for Indonesian electronics parts and components.

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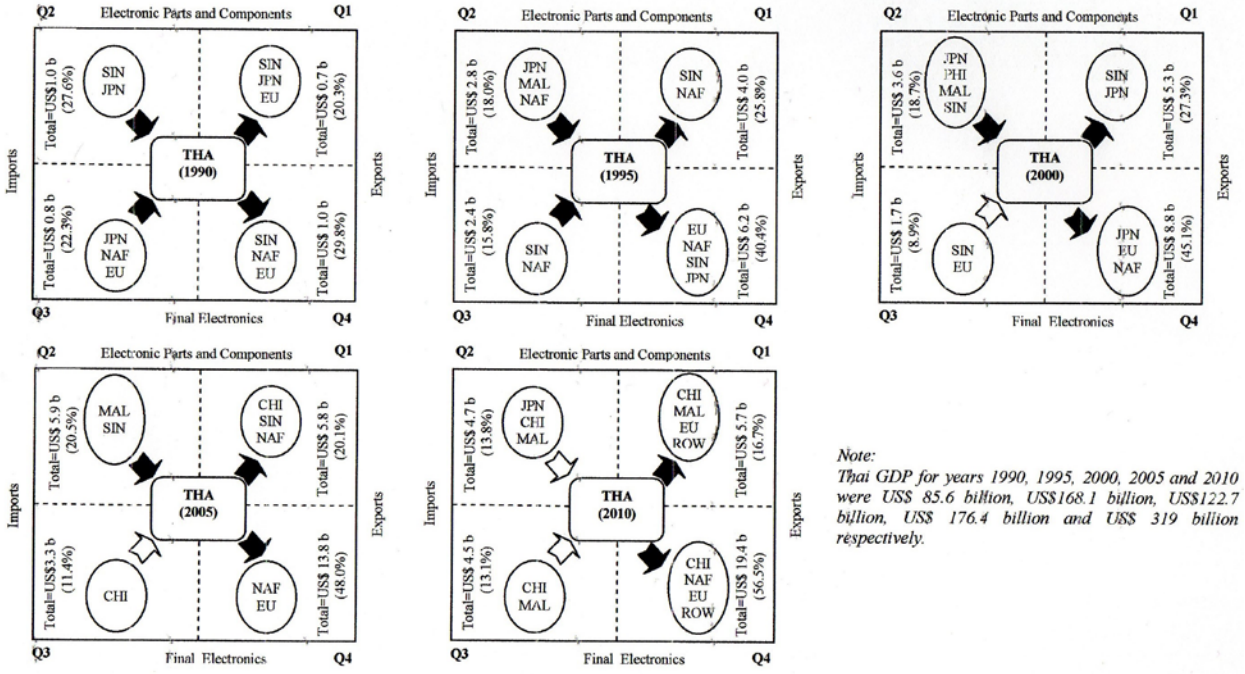
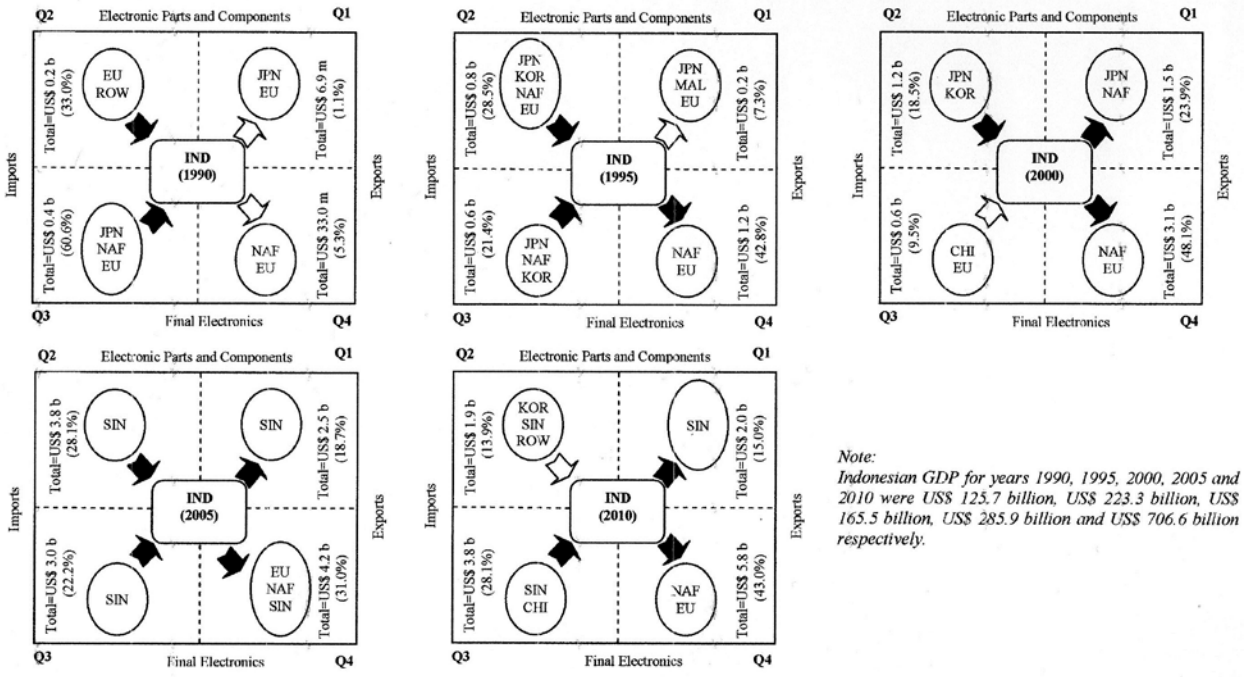
Figure 4: Thai Trade of Electronic Parts and Components and Final Electronics



Note:
Thai GDP for years 1990, 1995, 2000, 2005 and 2010 were US$ 85.6 billion, US$168.1 billion, US$122.7 billion, US$ 176.4 billion and US$ 319 billion respectively.

Figure 5: Indonesian Trade of Electronic Parts and Components and Final Electronics



Note:
Indonesian GDP for years 1990, 1995, 2000, 2005 and 2010 were US$ 125.7 billion, US$ 223.3 billion, US$ 165.5 billion, US$ 285.9 billion and US$ 706.6 billion respectively.

Several deregulation have been introduced in the mid-1980s following the shift in policy from import substitution towards export-oriented. This effort has encouraged joint ventures

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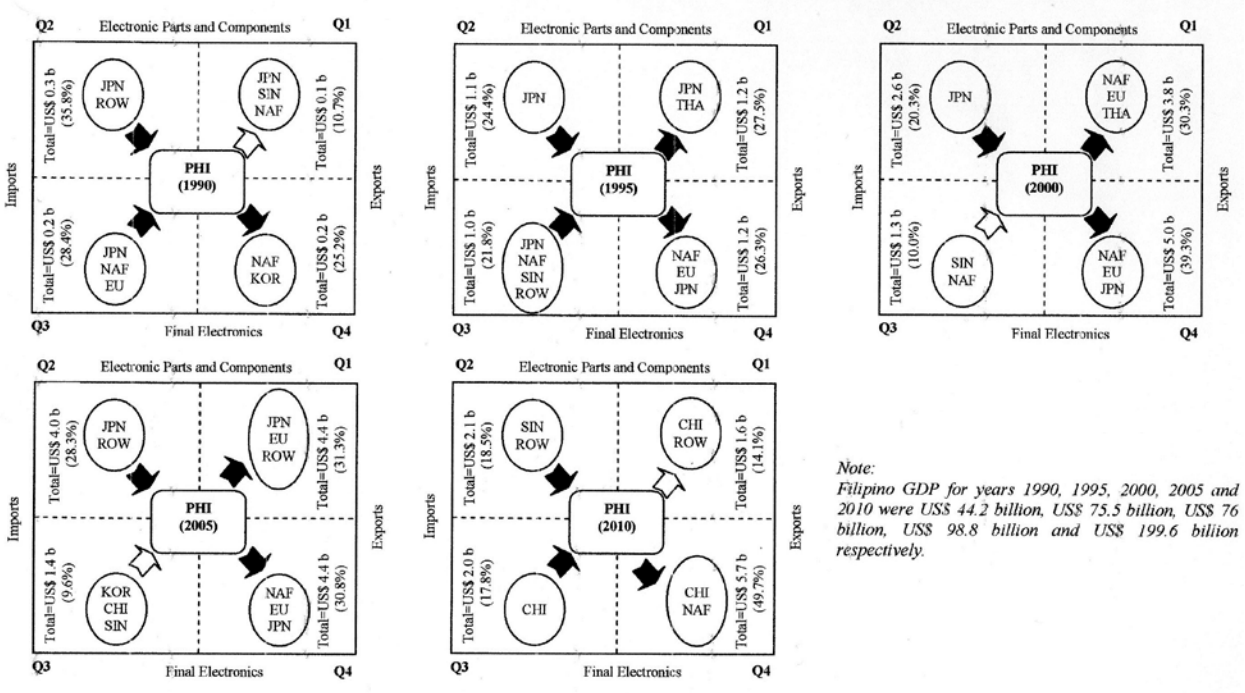
and local electronic producers to increase their consumer electronic exports. Before the 1997 Asian Financial Crisis, factories that produced cathode ray tube for television and active components (i.e., integrated circuits and semiconductor devices) had been set up. Meanwhile, the fiscal stimulus offered by the government in 2000 has resulted in a high demand for LCD TVs in Indonesia. As a result, several electronic producers such as Toshiba, Panasonic, Sharp, Samsung and LG chose Indonesia as their production base for LCD TVs. For instance, in 2005 LG Electronics Indonesia started producing LCD TVs with a capacity of around 50,000 units per month, while Panasonic Gobel Indonesia started producing LCD TVs and plasma TV with a capacity of 50,000 units per month in 2007 (Negara, 2010). Most of the TV components are still imported from the parent countries. For example, LG imported the panel for its LCD TVs from the Republic of Korea, while Panasonic imported its LCD panel from Japan. Similarly, almost all Toshiba components were imported from Japan and Taiwan (Negara, 2010).

For the Philippines, electronics industry is the largest contributor for its exports and played an important role for its economy development. Figure 6 illustrates the Philippines' position in electronic parts and components trade as well as final electronics trade between 1990 and 2010. Based on this figure, it is obvious that throughout the year under study the Philippines' role were more on as the importer electronic parts and components and the exporter of final electronics. Since 1995, the Philippines was also an important exporter of electronic parts and components. The figure also tells us that the main source of the Philippines' electronic parts and components was Japan, while the main destinations of its final electronics were NAFTA, EU and Japan.

Figure 6: Filipino Trade of Auto Parts and Components and Automobiles



Note:
Filipino GDP for years 1990, 1995, 2000, 2005 and 2010 were US$ 44.2 billion, US$ 75.5 billion, US$ 76 billion, US$ 98.8 billion and US$ 199.6 bilion respectively.

The success of electronic exports was mainly due to the large amount of investment received by the country's industry, particularly foreign investment in the 1990s. According to Lee (2005), the Philippines Economic Zone Authority (PEZA) estimates that between 1995 and

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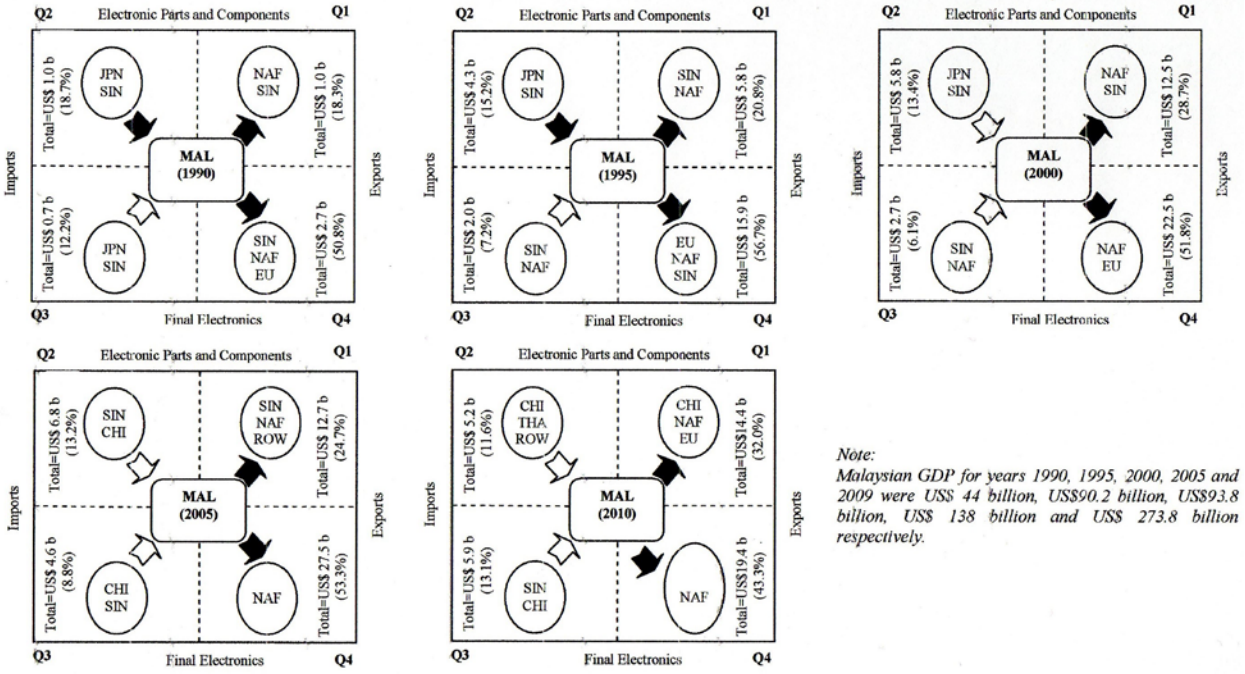
1999, 51 percent of the total PEZA investment was in the electronics sector. Throughout that period, exports from these zones increased from 22 percent to 50 percent of the total Philippine exports, wherein 85 percent of these exports were from multinational corporations. Japanese firms were the biggest contributor which account for around 46 percent of that figure. The government has implemented policy to attract direct foreign investments in the late 1980s in an effort to develop its economy and create jobs. The Board of Investment (BOI) and the Philippines Economic Zone Authority have been established to promote FDI. In addition, the government also opened a large number of industrial parks and developed essential infrastructures such as electric power and communication. Since the mid-1990s, the government has promoted an export-oriented policy and among steps that have been taken was the creation of clusters of HDDs producers and other peripheral PC equipment and related parts (Mitarai,2004).

For Malaysia electronics products is the main contributor to its manufacturing output, employment and exports. Malaysian position in electronic parts and components trade as well as final electronics trade between 1990 and 2010 has been illustrated in Figure 7. This figure indicates that Malaysia was an important exporter for both electronic parts and components and final electronics in those years. Malaysian's role as an important importer of electronic parts and component was only significant in the 1990s. The important markets for Malaysian final electronics were NAFTA (1990, 1995, 2000, 2005 and 2010), EU (1990, 1995 and 2000) and Singapore (1990 and 1995), while most of its electronic parts and component went to NAFTA (1990, 1995, 2000, 2005 and 2010), Singapore (1990, 1995, 2000 and 2005), ROW (2005), EU (2010) and China (2010).

Figure 7: Malaysian Trade of Electronic Parts and Components and Final Electronics



The development of production and exports of electronic products in Malaysia is highly influenced by government policies. The Malaysian government has made efforts to support

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the growth of the electronics industry. For instance, to attract foreign direct investments, many incentives have been offered to foreign manufacturing investors. They include the pioneer status[6], investment tax allowance, export credit financing, double deduction of export credit insurance and for export promotion, and incentives for R&D and training. Moreover, custom duty exemption on raw materials and machinery used directly in production is also provided to export-oriented manufacturers. To promote the electronics industry, the Malaysian government has established the Multimedia Super Corridor (MSC), Cyberjaya, and several new high-tech parks such as the Kulim High-Tech Park. In particular, MSC and Cyberjaya would stress R&D in electronics and information technology (IT). Meanwhile, the availability of an export processing zone (EPZ), lower-cost labour and other facilities such as roads, airports, harbours and communication is further evidence of the government's efforts to attract foreign manufacturers to invest in Malaysia.

Even though Singapore lost its competitiveness in low-end assembly operation in the mid-1990s when the country's labour cost rose significantly, several steps have been taken by the government to save the industry. Among efforts that have been taken are:

1. Singapore now focuses more on capital-intensive segments such as semiconductors and disk-drive production, and in R&D and product development.
2. The government, through the Economic Development Board (EDB), works aggressively to attract new foreign investments and to encourage existing industry players to reinvest in Singapore.
3. Special incentives directed at high-tech firms have also been meted out by the Singaporean government. Examples of those incentives are Research Incentives Scheme, Technopreneur Investment Incentive, and the Initiative in New Technology.
4. To reduce labour costs, the Singaporean government has taken measures such as lowering the mandatory pension contribution rate, while the average monthly wage levels in the sector have fallen slightly since 2000.
5. EDB has made efforts to improve the supply of skilled manpower for the electronics sector by collaborating with government educational institutions. For example, a training program in conjunction with the two main universities in Singapore has been launched by EDB to train engineers specializing in digital signal processing for multimedia and info-communication.

Singaporean position in electronic parts and components trade as well as final electronics trade between 1990 and 2010 has been illustrated in Figure 8. Based on the figure, we can see that Singapore was an important importer and exporter for both electronic parts and components and final electronics throughout the years under study. The important supplier of Singaporean electronic parts and components were Japan (1990 and 1995), Malaysia (1990, 1995, 2000 and 2009), China (2005 and 2010) and NAFTA (1990), while the important supplier for Singaporean final electronics were Japan (1990, 1995and 2000), Malaysia (1990, 1995, 2000 and 2005), China (2005 and 2010) and NAFTA (2000). Meanwhile, it is obvious that NAFTA and EU were the important markets for Singaporean electronic parts, components and final electronics. In certain years neighbouring countries like Malaysia and Indonesia also became an important market for Singaporean electronic parts and components.

[6] Total or partial exemption from income tax for a period of five years is awarded to a firm who acquires pioneer status.

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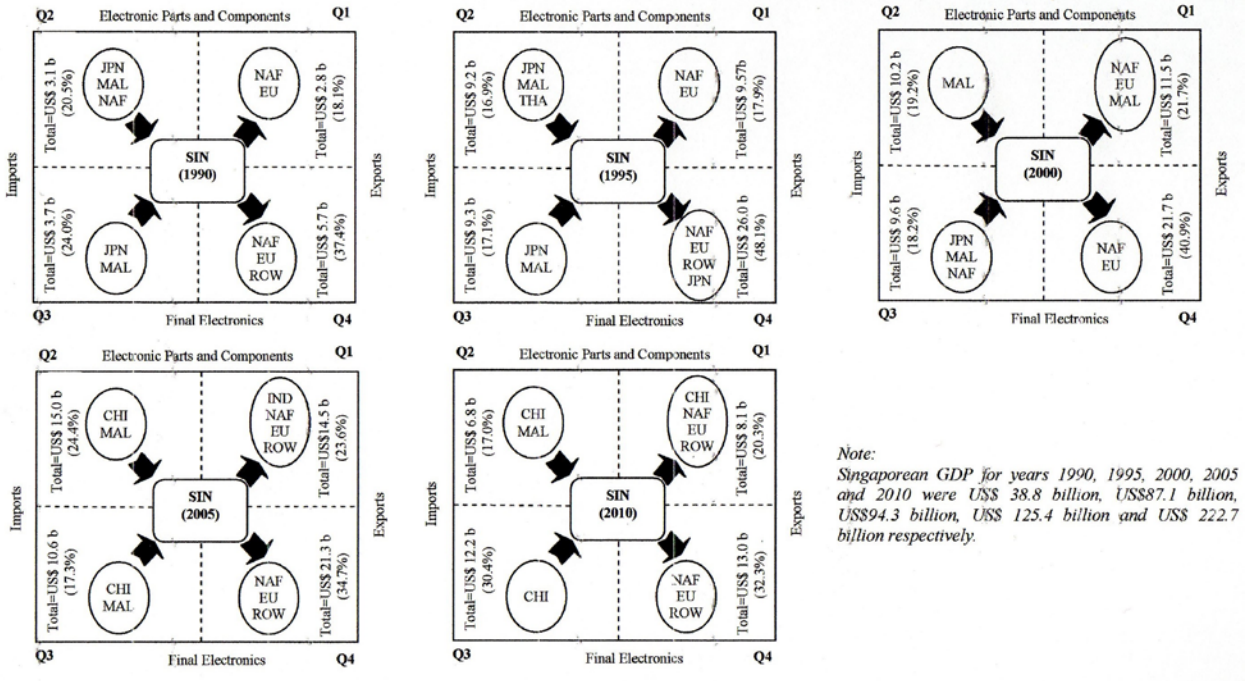
The Vietnamese electronics industry began to develop in the mid 1990s where major Japanese consumer electronics such as Matsushita, Sony, JVC and Toshiba started to form joint ventures with local enterprises (Mitarai, 2004). Figure 9 illustrated Vietnamese position in electronic parts and components trade as well as final electronics trade between 2000 and 2010[7]. Based on the figure, Vietnam became an important importer of electronic parts and components as well as final electronics in most of the years under study. In terms of final electronics, most of these products were imported from Singapore (2000 and 2005), the Republic of Korea (2000), and China (2000 and 2010), while for the electronic parts and components, Singapore, Malaysia and Japan were the main suppliers. Since 2005, however, Vietnam began to become an important exporter of electronic parts and components and most of these products went to NAFTA, EU and ROW.

The development of the Vietnamese electronics industry is heavily influenced by government policies. For example, in the 1990s the Vietnamese government started to encourage foreign investors to invest in Vietnam. Accordingly, the government established Industrial Zones (IZs) and Export Processing Zones (EPZs) to attract FDI into Vietnam. Foreign investors who operate in the zones would enjoy modern infrastructures such as good transportation and utility services as well as incentives such as reduction in corporate income tax and special reduction for newly established enterprises in IZs located in areas with difficult socio-economic conditions. In addition, the government also encouraged joint ventures particularly with state-owned companies.

Figure 8: Singaporean Trade of Electronic Parts and Components and Final Electronics



Note:
Singaporean GDP for years 1990, 1995, 2000, 2005 and 2010 were US$ 38.8 billion, US$87.1 billion, US$94.3 billion, US$ 125.4 billion and US$ 222.7 billion respectively.

[7] Data for the years 1990 and 1995 are unavailable.

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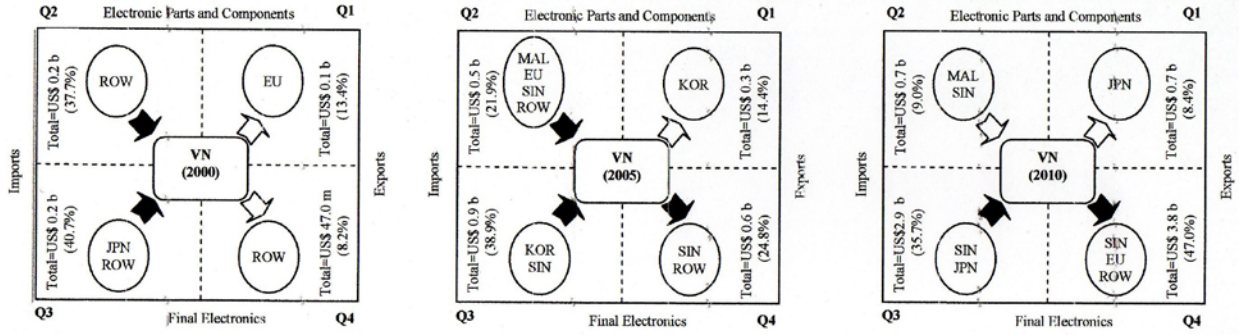
Figure 9: Vietnamese Trade of Electronic Parts and Components and Final Electronics



Note:
Vietnamese GDP for years 1990, 1995, 2000, 2005 and 2009 were US$ 6.5 billion, US$ 20.8 billion, US$31.2 billion, US$ 52.9 billion and US$ 103.5 billion respectively.

4.2 Network-level analysis

Rising production costs due to the appreciation of the Japanese Yen in the second half of the 1980s forced many Japanese firms to relocate their manufacturing to lower-labour-cost parts of Asian. The first wave in this shift was to Northeast Asia (viz. Republic of Korea, Taiwan, and Hong Kong). This was followed by the second wave to the Southeast Asian region (viz. Singapore, Malaysia, Thailand, Indonesia, and the Philippines). From Southeast Asia, the wave further shifted to China and more recently to Vietnam. According to Guerrieri (2000), there are two basic trends to be noted in terms of East Asia's electronics industry in the 1990s: (1) a great improvement in the competitiveness of East Asian countries; (2) intra-regional trade in electronics products accelerated significantly within the region. Not surprisingly, these developments have resulted in the emergence of a new centre for global electronics exports in the Asian region. This section examines the position of these countries in the international production chain as well as related development during the years 1990, 1995, 2000, 2005 and 2010.

Based on Table 6, it can be observed that dependence of most ASEAN countries on Japanese FDI seems to have been reduced due to the relocation of Japanese FDI to China. These changes began in Singapore and Malaysia. As can be seen in Table 6, the position of Malaysia and Singapore in the 1990s as "advanced middle" countries is influenced by their dependence-relationship with Japan. Since 2000, however, the domination of Japan in the electronics industry within these countries seemed to have disappeared. Nevertheless, this circumstance did not affect the position of both Malaysia and Singapore, for they have since upgraded their electronics industry and relied on each other for electronic parts and components through the intra-ASEAN trade. This relationship of interdependence has now determined their position in the international production network. In this respect, the most competitive countries are more likely to be located at a "higher" position, while the less competitive ones would be located at a "lower" position. In 2000, Malaysia seemed to have been more competitive in the production of electronic parts and components compared to

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Singapore and other ASEAN members[8]. Hence, Malaysia occupies the top spot in the international production chain as a "complex-advanced top" country, while Singapore is located at a lower place as an "advanced middle" country[9].

Since 2005, both Thailand and Indonesia have had experience similar to that encountered by Singapore and Malaysia. In that year, Malaysia still maintained its position at the top for being a "complex-advanced top" country, while Singapore, Thailand and Indonesia were deemed "advanced middle" countries (see Table 6). Nevertheless, based on the bilateral relationships between Singapore and Thailand (indicated by code PC1100) as well as between Singapore and Indonesia (indicated by code PC1110), we can say that Singapore is located at a higher position in the international production chain compared to Thailand and Indonesia. In this respect, Singapore was categorised as an "advanced middle level 1" country, while both Thailand and Indonesia were categorised as "advanced middle level 2" countries. In that year, Vietnam, which has improved its position from "advanced bottom" to "advanced middle", also relied on Singapore for its electronic parts and components.

Based on Table 6, Thailand has improved its position from an "advanced middle" country to a "complex-advanced top" country in 2010. This development is driven by the consolidation of Thai competitiveness in the production of electronic parts and components. Meanwhile, based on the bilateral relationships between Malaysia and Singapore (shown by code PC0100) as well as between Singapore and the Philippines (shown by code PC0100), Singapore is located at a position between Malaysia and the Philippines in the international production chain. The position of the Philippines as an "advanced middle" country throughout the period of study remains unchanged even though it lost Japanese attention in 2010. In that year, Japan's role as an important supplier of Filipino electronic parts and components was taken over by Singapore.

A massive injection of foreign investment into China by electronic producers from the New Asian Industrial Economies (NAIEs), the West and Japan has resulted in China becoming the world's main exporter of electronic products. In the 1990s, most of the electronic parts and components that flowed into China came from ROW[10]. In that period, China's position in the international production network was as an "advanced middle" country. Between 2005 and 2010, however, Japan and the Republic of Korea began to focus on China as their market for electronic parts and components[11]. This circumstance has inevitably strengthened China's role as the world's largest exporter of electronic products as well as retaining its position as an "advanced middle" country in the international production network.

[8]Code PC0100(T,V) in Table 6 indicates that both Thailand and Vietnam relied on Malaysian electronic parts and components, while code PC1110(S) indicates that Singaporean import of electronic parts and components from Malaysia was important and that both countries cared about such a transaction.

[9]Both Vietnam (an "advanced bottom" country) and Thailand (an "advanced middle" country) relied on Singapore for their electronic parts and components.

[10]The main player in this group of countries was Hong Kong.

[11]Besides Japan and the Republic of Korea, some ASEAN countries (i.e., Thailand and Malaysia) have also started to refocus their electronic parts and components market in terms of China.

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Table 6: International Production Network (IPN) in Electronics Industry

Country	Country's codes				
	1990	1995	2000	2005	2010
Japan	PC0100(M,S,R) FG0100(C,I,P,S,T,R) PC0110(N) FG0110(E,N) PC0010(E) PC1100(P,T)	PC0100(I,M,S,T) FG0100(I,K,C) PC0110(N) PC0010(E) FG0010(E) PC1100(P) FG1000(T)* **FG1100(P)** **FG0111(N)** **FG0101(S)**	PC0100(P) FG0100(S) PC0110(N) PC0010(E) FG0010(E) PC1100(T,J) FG0001(M)* FG1000(P,T)* **FG0011(N)**	PC0100(V) PC0110(N) PC0010(C,E,R) FG0010(E,N) PC1100(P) FG0001(C)* FG1000(P)*	PC0010 (C,N,R) FG0010 (N,E) **FG0011(C)**
	Complex-advanced top				
Thailand	PC0010(E) FG0010(S) PC0011(J,S) FG0011(E,N) FG0001(J)	PC0001(J,M) PC0110(S) FG0010(J) PC0011(N) PC1000(P) **FG0011(S,N,E)**	PC0001(M) PC0011(S,J) PC1001(P) FG0010(J,N,E)	PC0001(M) PC0010(C,N) FG0010(E,N) PC0011(S)	PC0010(C,M,E,R) FG0010(C,N,E.R)
	Advanced middle				**Complex-advanced top**
The Philippines	PC0010(N,S) FG0010(K) PC0011(J) PC0001(R) FG0001(J,E)*	FG0001(R) PC0010(T) FG0010(E) PC0011(J) **FG0011(J,N)**	PC0001(J) PC0010(E,N) FG0010(J,E,N) PC0110(T)	PC0010(E) FG0010(J,E,N) PC0011(J,R)	PC0001(S,R) FG0010(N) **FG0011(C)**
	Advanced middle				
Indonesia	PC0001(E,R) FG0001(J,E,N)	PC0001(J,K,E,N) FG0001(J) **FG0011(E,N)**	PC0001(K) PC0010(N) FG0010(E,N) PC0011(J)	FG0010(E,N) PC1011(S) **FG0011(S)**	FG0001(S,C)* PC0010(S) FG0010(E,N)
	Advanced bottom	**Advanced middle**			**Complex-advanced top**
China	PC0001(R) FG0001(J) FG0011(N,R)	PC0001(R) FG0001 (J) FG0010(N) FG0111(R) **FG0011(E)**	PC0010(E,N) FG0010(E,N) PC0110(R) FG0110(R)	PC0010(E) FG0110(E,N,R) PC0100(S) PC1000(K,T,J) FG0100(J,V,S) PC0110(N,R)	PC0100(R) PC1100(S) FG0100(K,V,I,S) FG0110(E,N,R) PC1000(M,J,T,K) **FG1100(J,P)** FG1000(T)
	Advanced middle	**Complex-advanced top**		**Advanced middle**	

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(continued)

Country	Country's codes				
	1990	1995	2000	2005	2010
The Republic of Korea	FG0010 (N,E) FG1000(P)*	PC0010(E) FG0010 (E,R) PC0100(I) FG0001(S)* FG0001(J) **FG0011(N)**	PC0010 (E,N) FG0010 (E,N) PC0100 (I)	PC0010 (C,E,N,R) FG0010 (E,N,R) FG0100 (V)	PC0010 (C,N,E) FG0010 (R,N,E) FG0001(C)*
	Basic top	**Complex-advanced top**			
Vietnam			PC0001(M,S) FG0001(E,S)	PC0001(J,S) FG0001(C,K,S) FG0010(E,N,R)	PC0001(J,S) FG0001(C) FG0010(N,E,R)
			Advanced bottom	**Advanced-middle**	
Malaysia	PC0001(J) PC0010(N) FG0010(N,E) PC0111(S)	PC0001(J) PC0010(N FG0010(E,N) PC0100(T) FG0110(S) PC0111(S)	PC0010(N) FG0010(N,E) PC0100(T,V) FG0100(J,S) PC1110(S)	PC0010(N,R) FG0010(N) PC0100(T) FG0100(S) PC0110(S)	PC0010(C,N,E) FG0010(N,E) PC0100(S) FG1110(T) PC1110(J,S)
	Advanced middle		**Complex-advanced top**		
Singapore	PC0001(J) FG0001(J) PC1000(P) PC1101(M) FG1000(T) PC0010(E) PC1100(T) PC0011(N)	PC0001(J) PC0010(E,N) FG0010(E,N,R) FG0100(K) PC1001(T) FG1001(M) **FG0101(J)** PC1101(M) **FG1100(T)**	PC0010(N,E) FG0010(E) FG0001(J,M) PC0100(V) FG0100(V) PC1011(M) PC1100(T) **FG0011(N)**	PC0001(C) FG0100(V) FG0001(M,C) PC1001(M) PC0010(N,R,E) PC1100(T) FG0010(N,E,R) **FG1100(I)** PC0100(V) PC1110(I)	PC0001(M) PC0011(C) FG0001(C) PC0100(P) PC0010(R,E,N) FG0100(I) FG0010(R,E,N) PC1000(I)
	Simple middle	**Advanced middle**			

Note: (1) The reciprocal transactions for final electronics are denoted in bold. We ignored those transactions when considering the position of each country.
*(2) *indicates the flows of final electronics from middle countries to their partners which are the top countries.*

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5. CONCLUSION

The aim of this study is to investigate electronic production in East Asia and to examine how it has evolved from 1990 to 2010. First, the key role played by each country in East Asia's international electronic production chain is explored by examining their Export Intensity Index (EII) and Import Intensity Index (III) in terms of trade in electronic parts and components and final goods. Second, each country's main trading partners are identified using their Export Share Index (ESI) and Import Share Index (ISI) to illustrate the trade network and level of dependence between countries. Third, the evolution of this trade network is investigated in terms of how countries' roles, trading partners and network patterns have changed in the years 1990, 1995, 2000, 2005 and 2010.

The results suggested that in general the role of Japan and the Republic of Korea in the 1990s expanded to becoming exporters of electronic parts and components and final electronics as well as importers of final electronics. In contrast, the role of Malaysia and Thailand seems to have been confined to being exporter of both electronic parts and components and final electronics. Interestingly, the development in the role of Thailand was similar to that experienced by Malaysia; the only difference is that Thailand experienced it at a later time. Meanwhile, some countries such as Indonesia, the Philippines and China experienced erratic changes in their role, while that of Singapore remains unchanged. The results also indicate that the relocation of Japanese and Korean FDI to lower-labour-cost countries such as China in the 2000s has forced some ASEAN countries to each upgrade their electronics industry and emerged as a main supplier of electronic parts and components for their neighbouring countries. These circumstances, in turn, have changed the pattern of hierarchy within the international electronics production network in the ASEAN region. Meanwhile, a massive injection of foreign investment into China by electronic producers particularly from Japan and the Republic of Korea in the 2000s has resulted in China becoming the world's main exporter of electronic products.

There are of course several limitations to a study such as this. The unavailability of data for the value of domestic electronic parts and components, as well as final electronics produced and sold within the country under study was significant, so was the unavailability of data for Taiwan. Thus, we were unable to analyse the role of Taiwan within the supply chain of East Asia's electronics industry. Moreover, the cut-point that we used in our analysis is somewhat arbitrary. For future research then, we intend to conduct an empirical analysis using a spatial approach to explore the relationship of interdependence among countries in the international production chain.

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