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International Production Networks And Changing Trade Patterns In East Asia: The Case Of The Electronics Industry

by
Dieter Ernst & Paolo Guerrieri
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INTERNATIONAL PRODUCTION NETWORKS AND CHANGING TRADE PATTERNS IN EAST ASIA: THE CASE OF THE ELECTRONICS INDUSTRY

by

Dieter Ernst
Copenhagen Business School and the Berkeley Roundtable on the International Economy (BRIE), University of California at Berkeley
e-mail: sprqkde@merkur.cbs.dk

and

Paolo Guerrieri
University of Rome "La Sapienza"
e-mail: mc1976@mclink.it

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Abstract

The purpose of this paper is to analyze how the spread of different international production networks in East Asia has affected the trade links of the region with the U.S. and Japan. We concentrate on one particular aspect, i.e. changes in the product composition of U.S. and Japanese electronics exports and imports to and from the East Asia region. We find that compared to the U.S. , Japan's trade links with East Asia display a far greater diversity of the product groups involved. Of equal importance is a second finding: the trade balances of both countries with the region are radically different. A consistently high and growing trade deficit characterizes U.S. trade links with East Asia in the electronic industry. This is true even for computers and components, the two sectors where the U.S. has re-established itself during the last few years as an uncontested leader. This is in stark contrast to the situation in Japan, where a large and rapidly growing surplus characterizes its trade links with East Asia. Although this is now slowly changing as East Asia has become the most important source of Japanese electronics imports, there is reason to doubt whether this positive development is strong

enough to reduce any time soon the asymmetric nature of Japan's trade links with East Asia.

These differences can only be partially attributed to traditional macroeconomic factors that are the focus of standard trade theory. In the paper, we show how the observed differences can be better explained by some peculiar features of the international production networks that American and Japanese firms have established in East Asia. The chain of causation appears to work both ways. Changes in the organization of international production have led to changes in the composition of bilateral trade flows. Such changes in international trade patterns, in turn, lead to further changes in the organization of international production.

Keywords

international trade; international investment; economic development; business strategies; networks; Japan; USA; Asia; electronics industry.

JEL Classification

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Preface

We are happy to integrate international scholars in the DRUID network and to publish their contributions in the DRUID working paper series. This is especially so when the papers contribute to the over all research programme of DRUID.

This paper by Dieter Ernst and Paolo Guerreri links together two phenomena which are often treated separately - the pattern of trade specialisation (related to Theme C in the DRUID research programme) and the formation of international industrial networking relationships (related to theme B). Comparing the experiences of respectively the US and Japan regarding their trade with East Asia it is demonstrated that in the field of electronics there is a close connection between how the vertical division of labour in international production networks is shaped on the one hand and the pattern of specialisation and the trade balance on the other.
These results are certainly interesting in their own right and from an empirical point of view. But, they also point to the need to integrate theoretical elements from strategic management into theories of international trade and competitiveness.

Bengt-Åke Lundvall

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Dieter Ernst[+]
Copenhagen Business School and the Berkeley Roundtable on the International Economy (BRIE), University of California at Berkeley. E-mail: sprqkdebs.dk **and Paolo Guerrieri**[*]
University of Rome 'La Sapienza'. E-mail: mc1976@mclink.it

1. Introduction

Over the last three decades, East Asia has witnessed a massive expansion of international production by foreign electronics firms. The focus of such investment has shifted twice: first from Northeast Asia (Korea, Taiwan and Hong Kong) to the Asean region (primarly Singapore, Malaysia and Thailand); and more recently, from the Asean region to China and also now to Vietnam. Foreign electronics firms thus have substantially extended the geographic coverage of their Asian production activities. At the same time they have proceeded to integrate their erstwhile stand-alone operations in individual host countries into increasingly complex international production networks [2].

The firms involved in such international production networks are an increasingly heterogeneous group. This is true not only for their nationality, but also for their size, their organization and their competitive strengths and strategies.Today, large multinationals from the U.S., Japan and Europe no longer are the only carriers of international production in Asia. Three types of newly emerging networks are now also active in the region: those established by Korean chaebol; those established by Taiwanese producers of PC-related products and components in Southeast Asia and China; and those networks of suppliers of parts and sub-assemblies based in Hong Kong, Taiwan, Singapore and mostly owned by ethnic Chinese[22].

Across the spectrum of the electronics industry, the region is thus witnessing the proliferation of competing international production networks that are beginning to change the rules of competition, the market structures, and the prevailing patterns of technology diffusion. This has important implications for the region´s trade patterns. Peculiar features of these international production networks have strongly affected the direction of trade flows, the trade specialization and the foreign trade balances both of host and home countries.

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[2] The concept of an "international production network" is an attempt to capture the spread of broader and more systemic forms of international production that cut across different stages of the value chain and that may or may not involve equity ownership. This concept allows us to analyze the globalization strategies of a particular firm with regard to the following four questions: 1) Where does a firm locate which stages of the value chain? 2)To what degree does a firm rely on outsourcing? What is the importance of inter-firm production networks relative to the firm's internal production network? 3) To what degree is the control over these transactions exercised in a centralized or in a decentralized manner? And 4) how do the different elements of these networks hang together? For details, see Ernst, 1994a; 1996; 1997a and 1997b; and Ernst and Ravenhill, 1997

[22] For an analysis of some of these newly emerging Asian production networks, see Borrus, 1993; Ernst, 1997b and Kim Youngsoo, 1996. A brief comparative analysis can be found in: Ernst, 1997 a.; and Ernst and Ravenhill, 1997.

The purpose of this paper is to analyze how the spread of different international production networks in East Asia has affected the trade links of the region with the U.S. and Japan. We concentrate on one particular aspect, i.e. changes in the product composition of U.S. and Japanese electronics exports and imports to and from the East Asia region. We find that compared to the U.S. , Japan's trade links with East Asia display a far greater diversity of the product groups involved. Of equal importance is a second finding: the trade balances of both countries with the region are radically different. A consistently high and growing trade deficit characterizes U.S. trade links with East Asia in the electronic industry. This is true even for computers and components, the two sectors where the U.S. has re-established itself during the last few years as an uncontested leader. This is in stark contrast to the situation in Japan, where a large and rapidly growing surplus characterizes its trade links with East Asia. Although this is now slowly changing as East Asia has become the most important source of Japanese electronics imports, there is reason to doubt whether this positive development is strong enough to reduce any time soon the asymmetric nature of Japan's trade links with East Asia.

These differences can only be partially attributed to traditional macroeconomic factors that are the focus of standard trade theory[222]. In the paper, we show how the observed differences can be better explained by some peculiar features of the international production networks that American and Japanese firms have established in East Asia. The chain of causation appears to work both ways. Changes in the organization of international production have led to changes in the composition of bilateral trade flows. Such changes in international trade patterns, in turn, lead to further changes in the organization of international production.

As long as we only consider explanations derived from standard trade theory, we thus may well miss some opportunities for a deeper understanding of how international production and trade interact. In order to explain international trade patterns, trade theory should place FDI and international production networks at the centre of the analysis. Unfortunately, there is very little theoretical work on this relationship. Pioneering attempts to establish a unified analysis of FDI and international trade are the international product life cycle theory of Vernon and the technology gap trade theory of Posner[2222]. A few other scholars have tried to link the theory of foreign direct investment to that of industrial organization of multinational enterprises [22222]. Yet, this has hardly affected the main stream

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[222] For an attempt to explain Japan´s trade links with Asia with standard trade theory, see Urata, 1993.

[2222] Vernon , 1966 and 1979; and Posner, 1961.

[22222] Dunning, 1981, 1993; Cantwell, 1989; and Lall, 1980.

of trade theory: we still lack a unified theory of trade and FDI[222222].

The aim of this paper is certainly not to fill this theoretical gap. We have a much more limited goal: to provide some empirical evidence and to introduce some stylized facts on the interaction between trade, FDI and international production networks. We use as a test case the spread of American and Japanese international production networks in East Asia

The paper is organized as follows. The second section has an introductory character and compares changes in the product composition of U.S. and Japanese electronics and imports. The following two sections 3. and 4. have a twofold purpose: They document important differences in the trade links that the US and Japan have established with East Asia in the electronics industry. At the same time, we attempt to explain some of these differences by relating them to some peculiar features that distinguish American and Japanese production networks in Asia. Section 4 also addresses a politically sensitive issue: are Japanese asymmetric trade links with East Asia likely to decrease over time? We conclude with a brief discussion to what degree our findings can be generalized and lay out a few issues for follow-on research.

222222 One encouraging sign is that trade theorists are now more willing to address a research agenda that is shaped by the assumptions of evolutionary economics (Marshall, 1919 ; Schumpeter, 1912 and 1947; Penrose, 1959; Freeman, 1982; Nelson and Winter, 1982; Lundvall, 1988; Andersen, 1994; and Malerba and Orsenigo, 1996). See, for example: Guerrieri, 1993; 1994; Dalum et al, 1996

2. A comparison of changes in the product composition of U.S. and Japanese electronics exports and imports

2.1 The Changing product composition of U.S. trade

In the US, both exports and imports are dominated today by the same two product groups, i.e. electronic data processing (EDP) and electronic components. Their combined share in exports, since 1989, has remained fairly constant between 66 and 68%. Their combined share in US imports, however, has substantially increased, from nearly 52% in 1989 to nearly 60% in 1993. While consumer electronics has been the leading import item till 1988, it has been overtaken first by EDP, and , since 1993, also by electronic components.

TABLE 1

Electronics Trade composition: the UNITED STATES

(in percentage, Total Electronics Trade = 100)

U.S.	EXPORT			IMPORT		
	1980	1989	1993	1980	1989	1993
Electronic Data Processing	49,2	48,5	41,0	5,4	32,3	39,0
Office Equipment	6,9	4,1	2,6	10,5	6,5	5,1
Telecommunication	3,7	4,6	5,5	2,9	5,3	4,6
Electronic Components	13,4	22,5	27,1	24,2	19,5	20,7
Consumer Electronics	9,9	7,9	10,6	32,5	21,7	18,6
Household Appliances	5,3	3,0	3,2	5,8	4,8	4,0
Other Electronics	11,6	9,4	10,0	18,7	10,0	8,1
Total Electronics	100	100	100	100	100	100

Source: UN and OECD trade data, from SIE World Trade Data Base

EDP has consistently dominated electronics exports since 1980. While this share has declined from more than 48% in 1989 to 41% in 1993, the US electronics industry continues to be centered on the computer industry. It is interesting to note that EDP has substantially increased its share of US electronics imports: EDP has been the largest import item since 1989, and its share in US imports has increased from 32% to 39% in 1993.

The increasing share of EDP in US imports indicates the rapid globalization of the US computer industry. East Asia has played a critical role as an increasingly important supply base both for final assembly and component manufacturing (Encarnation, 1992; Hobday, 1993; and Ernst, 1996).

TABLE 2

United States : Geographic Electronics Trade Composition (percentage of Total Trade)

Total Electronics Trade

Export

	1970	1980	1985	1990	1992	1994
WORLD	100	100	100	100	100	100
ASIA	64,6	72,1	78,2	77,4	76,7	78,2
Japan	55,0	35,1	49,7	38,5	35,8	32,2
NICs in ASIA	9,5	26,7	22,6	28,7	26,8	27,1
Singapore	0,2	7,4	5,6	10,2	9,6	10,1
Korea	0,3	5,0	5,7	7,6	6,6	7,3
Taiwan	4,8	8,4	7,2	7,8	8,0	7,9
Hong Kong	4,2	5,9	4,2	3,1	2,5	1,7
China	0,0	0,0	0,1	2,1	3,1	4,9
ASEAN	0,0	10,2	5,7	8,1	11,0	14,1
Thailand	0,0	0,6	0,5	2,1	2,7	3,0
Malaysia	0,0	6,4	3,5	4,6	6,4	8,5
Indonesia	0,0	0,4	0,1	0,0	0,4	0,7
Philippines	0,0	2,9	1,7	1,3	1,6	1,8
NAFTA	12,4	13,6	9,5	12,0	12,5	12,4
Canada	9,0	6,5	4,7	6,0	6,4	5,5
TOTAL EUROPE	22,0	12,7	10,4	9,6	9,4	8,3
EU (15)	17,9	11,0	9,5	8,7	8,6	7,5

Source: UN and OECD trade data, from SIE World Trade Data Base

Table 2 clearly confirm that East Asia has become an increasingly important source for US electronics imports. CE dominated until but its has since then been overtaken by EDP-related products. As we will discuss later on in detail, these EDP-related imports largely result from the expansion of the production networks of American computer companies.

This needs to placed in the proper context: Until the late 1960s investment in the electronics industry in Asia was dominated by a handful of large multinationals from Europe and Japan, with relatively little U.S. involvement. Especially for consumer electronics and telecommunications equipment, the main motivations were tariff-hopping and attempts to reap the substantial windfall profits available in the highly protected domestic markets. Since then, the focus has gradually shifted to export platform production[2222222]. This change was pioneered by American producers of semiconductors and computer peripherals and their investment in labor-intensive assembly lines. An equally important role was played by American producers and mass merchandisers of household appliances who outsourced an increasing variety of such products to independent OEM suppliers. American producers of PC-related products, including a variety of semiconductor devices, have played a pioneering role in establishing export platform production networks in East Asia. They have introduced new forms of organizing international production that did not necessarily involve equity control. It is this early lead in the development of new and indirect forms of organizing international production that may have conveyed substantial competitive advantages to US computer companies. And it is this pattern that also determined US computer companies increasing dependence, over the years, on input imports from East Asia. This dependence extends now well beyond Japan and includes a variety of East Asian countries. Less than a decade ago, their sole attraction used to be cheap labor. Today, these countries have accumulated an impressive array of production and innovation capabilities[22222222].

2.2 The Changing product composition of Japanese trade

Japanese exports, until 1988, used to be dominated by CE (Table 3). Since then, EDP has taken over as the leading export category, and electronic components have moved up to the second position for the first time in 1989. This trend indicates that by the end of 1980s Japanese electronics exports have a much more balanced composition than those of the US.

[2222222] For a detailed analysis, see Ernst, 1996; Guerrieri, 1995.

[22222222] The process of local capability formation in the Korean electronics industry is analyzed in Ernst, 1997c.
A systematic analysis of the formation of technological capabilities in the electronics and textile industries of East Asia can be found in: Ernst, Mytelka and Ganiatsos, 1997.

TABLE 3

Electronics Trade composition: JAPAN

(in percentage, Total Electronics Trade = 100)

JAPAN	EXPORT			IMPORT		
	1980	1989	1993	1980	1989	1993
Electronic Data Processing	4,6	26,2	30,0	40,2	36,8	36,4
Office Equipment	13,6	9,3	8,5	5,5	3,0	2,2
Telecommunication	2,8	7,0	5,7	1,5	4,9	5,4
Electronic Components	9,0	19,2	24,1	29,0	24,7	27,4
Consumer Electronics	55,1	25,9	19,7	14,7	21,7	20,1
Household Appliances	5,4	1,9	1,5	2,5	3,9	3,3
Other Electronics	9,5	10,5	10,4	6,6	5,0	5,2
	100	100	100	100	100	100

Source: UN and OECD trade data, from SIE World Trade Data Base

For CE, Japanese firms have clearly shifted from export to international production as the main vehicle for penetrating foreign markets. Both for CE and household appliances, there has been a rapid increase of sales of Japanese overseas affiliates relative to exports, with most of these export platform activities concentrated in Malaysia, Thailand, China and the ;exican maquiladores (Riedel, 1991; Petri, 1992).

For EDP, Japanese exports consist primarily of peripheral equipment (printers, floppy disk drives) and portable PCs (primarily from Toshiba). Since 1990, their share in Japanese electronics exports has increased only relatively slowly. This indicates that, also for EDP, international market share expansion through exports may now have run its course, and that Japanese EDP producers will have to increase their reliance on international production.

Probably the most interesting development is the increasing share of electronics components in Japanese exports. It increased from 9% in 1980 to more than 19% in 1989, then stagnated between 1990 and 1992 between 18% and slightly more than 20%, and has taken off since then to nearly one quarter of Japanese exports. Three developments have been of particular importance[222222222] :

[222222222] Based on Ernst,1997 a.

First, in response to the Yen appreciation, Japanese CE producers all shifted production to Southeast Asia, China and Mexico, and thus had to increase their exports of CE-related electronics components. Increasingly however, such components are now procured from sources outside Japan, with the result that their share in exports has declined.

Secondly, since the mid-1980s, Japanese IC producers have clearly overtaken their US rivals, and thus were able to increase their exports to the US and Europe. Since around 1992, such exports however are now increasingly substituted by sales from Japanese overseas affiliates that have been established close to the major IC markets.

Thirdly, since around 1992, Japanese EDP producers are under increasing pressure from aggressive price war strategies of US computer companies. In response, they have increased their OEM/ODM purchases in Asia and have begun to shift production to this region. This, in turn, has induced an increase of exports of electronics components, especially ICs, to overseas suppliers and assembly affiliates of Japanese firms.

Changes in the composition of Japanese imports have been also very pronounced and have been shaped by a number of different forces. Two product group have dominated Japanese electronics imports by the early 1980s: EDP and electronics components. Since then, their combined import share has declined from more than 69% in 1980 to less than 62% in 1989, due to the strong rise of CE imports, that has been increased from 14% in 1985 to almost 21% in 1993.
The increasing share of CE in Japan's import clearly indicates the rapid expansion of Japanese affiliates abroad, especially in East Asia and the rise of this region as the main source of CE products to Japan.

In absolute figures also EDP imports have risen, but in relative terms (percentage shares) the figures are lower than we would have expected. One should recall that since around late 1991, foreign companies (primarily American but also some Taiwanese companies) have considerably increased their share of the Japanese PC market. Until then, the Japanese market was an almost exclusive preserve for a handful of Japan's giant, diversified electronics makers, each of which had their own operating system and attendant software libraries[2222222222] .

[2222222222] NEC by far controlled the largest fiefdom, wich a seemingly impregnable 80% market share. Foreign companies, even the most powerful ones, nibbled in frustation at tiny pockets of demand for non-Japanese operating system - mainly among affiliates of foreign multinationals and banks that required foreign-language computers. All of this has changed drastically, since PCs (using Intel's 386 and 486 MPUs) have become powerful enough to handle Japanese language operating systems based on MS-DOS version five, called DOS V/J (where the "J" stands for Japanese).
Nobody should underestimate the determination and capacity of Japanese computer companies to develop powerful new market deterrence strategies that would enable them to fend off foreign

As for the import share of electronic components, it declined consistently from 29% in 1980 to around 25% in 1992. This is consonant with the growing strength of the Japanese electronic component industry during this period. In 1993, the most recent year, the share of electronics components in Japanese imports began to increase again, to more than 27%. This reflects the eroding competitiveness of domestic component production, due to the Yen appreciation, and the development of domestic component industries in East Asia, especially in Taiwan, South Korea and Singapore. It is to be expected that the share of components in Japanese imports will continue to increase in the future.

2.3 Mutual Integration of International Production Networks - Bilateral trade in electronics between the US and Japan

US exports to and imports from Japan (see Table 4) are again dominated by the same two product groups that we have identified in table 1: EDP and electronic components. There are however important differences in the trade composition of both countries. These differences reflect the fact that of all countries in East Asia, Japan has been the least accessible to US exports and FDI. As a result, Japan's integration into US international production networks [IPN] has remained quite limited. Yet, as our figures show, this is now beginning to change.

Let us first look at how the composition of US exports to Japan differ from the general product composition of US electronics exports, described in table 1. EDP and components together have a much higher share in US exports to Japan than they do for US exports in general: their combined

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competitors. As the growth of Japanese PC exports will continue to slow down, Japan's domestic market will become even more important as the main source of demand for Japanese cvomputer companies. Competition for the domestic market thus is likely to intensify further, and Japanese computer makers will certainly go out of their way to sustain their domestic market shares against foreign penetration.
Yet, there are also reasons for optimism. Fundamental changes in the Japanese market may have a last reduced the entry barriers. Japanese companies, including the large corporations, are under intense restructuring pressure, and are thus forced to shift to lower-cost PC-based networking solutions, to the detriment of mainframe and microcomputer purchases. Gone are the days when Japanese corporate customers could indulge in excessive brand loyalty to high-priced Japanese computer systems. In the current recession, brand snobbery had to give way to an increasingly price-conscious buying behaviour and a taste for bargain shopping. Japan's shift to the open architecture DOS/V operating system, combined with the rapid price erosion for these machines, also has added a variety of new customers: Japanese SMEs can now afford to buy PC-based systems, while Japan is now experiencing for the first time the development of a large home PC market, mainly for multi-media related desktops. As a result, Japanese firms have rapidly lost marker share, especially for the home PC market, which, in 1994, has grown by an estimated 35%. Domestically produced PCs accounted for only 9% of this growth, while the remaining 26% or so were either OEM products producerd in Taiwan or OBN imports from the US, Taiwan and Europe. (Ernst, 1997a)

share increased from 65% in 1988 to 76% in 1990, and has since then settled at around 74% in 1993. One underlying cause is easy to explain: the continuous increase, since 1985, in the share of electronic components, from slightly more than 14% to more than 26% in 1993. The US-Japanese trade agreement on semiconductors, concluded in September 1986, obviously has played an important catalytic role in increasing the market penetration of US component exports[22222222222] .

[22222222222] Apart from fixing a minimum pricing threshold for Japanese exports to the US, the agreement contained an informal side letter that stipulated that the Japanese government had agreed, at least tacitly, to facilitate an increase in the market penetration of US semiconductor exports.

TABLE 4

Electronics : U.S. Bilateral Trade Composition with JAPAN

(in percentage, Total Electronics Trade = 100)

United States

EXPORT

versus JAPAN

	1980	1985	1988	1990	1993
Total Electronics trade	100	100	100	100	100
Electronic Data Processing	60,4	51,4	46,8	56,9	47,7
Office Equipment	4,4	2,4	1,6	2,2	1,4
Telecommunication	0,9	2,2	3,0	4,9	6,9
Electronic Components	16,3	14,3	18,2	18,6	26,4
Consumer Electronics	8,3	5,0	7,8	8,2	9,1
Household Appliances	2,5	1,5	1,0	0,9	1,0
Other Electronics	7,2	23,2	21,6	8,3	7,4

IMPORTS

versus JAPAN

	1980	1985	1988	1990	1993
Total Electronics trade	100	100	100	100	100
Electronic Data Processing	2,5	7,0	15,6	34,2	38,9
Office Equipment	17,9	11,4	9,8	9,8	9,4
Telecommunication	3,2	5,5	6,4	5,3	4,8
Electronic Components	9,2	7,6	13,8	14,4	18,9
Consumer Electronics	45,6	44,5	29,8	22,7	16,7
Household Appliances	5,9	4,0	1,8	1,2	1,1
Other Electronics	15,7	20,1	22,8	12,5	10,1

It is much more difficult to interpret the figures for EDP. As already noted, the Japanese PC market has been gradually forced open since late 1991. The result has been a rapid fall in the market share of the Japanese companies, especially NEC, the erstwhile unchallenged market leader, and a substantial increase in the market share of the US companies, like IBM Japan, Compaq, and other US manufacturers. If penetration of the Japanese market would occur through exports, one would expect to find an increasing share of EDP in US exports to Japan after 1990. Table 4 shows that this

has not been the case. The only possible explanation is that sales of US computer companies to the Japanese market increasingly originate from within East Asia rather than from the US. IBM for instance serves the Japanese market almost exclusively from its Japanese affiliate and from a number of component and subassembly manufacturing sites in East Asia. Apple, Compaq and Hewlett Packard all have concentrated an increasing share of their production in East Asia, most of it centered around Singapore. Much of this production involves a variety of outsourcing arrangements, ranging from contract manufacturing of printed circuit boards, to a variety of OEM and ODM contracts, primarily with Taiwanese suppliers. Both developments are important indicators of the rapid expansion and deepening that is currently taking place in the Asian production networks of American computer firms. The result is that a decreasing share of US EDP sales in Japan result from exports; increasingly, such exports are substituted by sales that originate from within East Asia.

Let us now look at US electronics imports from Japan. By the first half of the 1980s CE still covered almost half of the US imports. Since then however its share has drastically declined. This reflects an important element of the restructuring of Japan´s electronics industry: after 1985, Japanese vendors of CE have rapidly shifted from exports to shipments from overseas affiliates, primarily located in Southeast Asia[222222222222].

By the first half of the 1990s, EDP and components dominate US imports from Japan. The combined share of both products has rapidly increased from 29% in 1988 to 49% in 1990, and to 58% in 1993. This has been driven primarily by the rapid increase in the share of EDP from less than 16% in 1988 to almost 39% in 1993. These imports consist of laptop computers (mostly from Toshiba), peripherals, especially printers (mostly from Canon), and a variety of PC related products that are either jointly developed or where Japanese firms act as an OEM/ODM supplier. There are no data available in the public domain that allow us to determine the share of Japanese brandname products relative to the share of products that result from subcontracting or OEM/ODM arrangements. We know however from confidential interviews that the share of such outsourcing arrangements can be substantial. The increasing share of EDP in US imports from Japan thus is a clear indication that, at long last, the IPN of American and Japanese computer companies become more intertwined.

[222222222222] Ernst 1997a

3. How international production networks have shaped U.S. trade links with East Asia

US exports to the East Asian region, with but one important exception, have been dominated by electronic components (Table 5). The share of components in US electronics exports ranges from 83% in Malaysia, to 56% in Taiwan, 52% in Thailand, 51% in Singapore, nearly 50% in Korea, 49% in Hong Kong. The noteworthy exception is China where the share of components has fallen from more than 12% in 1990 to less than 2% in 1993, while EDP and telecommunications equipment are by far the most important export categories.

As for US imports from these countries, we find a variety of results which reflect the different stage of development of each of these countries and the different role that each of these locations play as export platforms for the US market. EDP clearly dominates US imports from Singapore (mainly hard disk drives) and Taiwan (motherboards, PCs and a variety of PC-related components and subassemblies). EDP also is the leading import category for US imports from Thailand and Hong Kong, yet in both countries components and CE also play an important role. Electronic components dominate US imports from Korea, while CE is rapidly declining in importance. The share of EDP has rapidly increased, yet it remains way below the share in US imports from Taiwan or Singapore. Electronic components traditionally used to dominate US imports from Malaysia. CE however has substantially increased in importance since 1988, as does EDP after 1990. China finally adds another shade of color to the variety of product compositions of US imports from East Asia: consumer electronics plus household appliances continue to play a dominant role, while EDP has recently begun to increase its share.

How do we explain this diversity of trade patterns that link the US with East Asia? In other words, are changes in comparative advantages based on factor endowment and costs sufficient to explain changes in the product composition of international trade? Or do we not miss some opportunities for a deeper understanding of how international production and trade interact, as long as we only consider comparative advantages? We argue that the proliferation of competing international production networks has been a major cause for the observed changes in the product composition of U.S. trade links with East Asia. In effect, the diversity of trade patterns of East Asian economies reflect differences in the export specialization of different countries as well as differences in their integration in various IPN.

TABLE 5

Electronics : U.S. Bilateral Trade Composition with EAST ASIAN Countries

(in percentage, Total Electronics Trade = 100)

USA

% Composition of Exports

	versus Taiwan					versus South Korea					versus Hong Kong					versus Singapore				
	1980	**1985**	**1988**	**1990**	**1993**	**1980**	**1985**	**1988**	**1990**	**1993**	**1980**	**1985**	**1988**	**1990**	**1993**	**1980**	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	23,6	27,2	20,9	20,7	17,7	21,6	17,7	26,7	31,7	23,0	59,1	49,3	33,9	29,5	29,8	24,7	39,6	47,9	33,8	31,1
Office Equipment	1,3	1,0	0,6	0,7	0,5	1,5	0,9	1,1	2,0	0,7	3,3	2,5	1,3	1,7	1,2	5,1	2,3	1,2	1,8	0,8
Telecommunication	17,0	8,4	6,8	13,5	4,0	10,5	11,8	5,5	6,6	5,1	3,4	3,8	6,8	3,6	3,3	2,7	1,4	1,2	2,1	1,8
Electronic Components	17,7	31,5	35,8	39,9	55,9	37,7	52,9	48,8	47,2	50,3	19,6	26,7	35,7	49,2	49,1	43,2	42,9	31,5	41,6	51,4
Consumer Electronics	12,3	5,9	8,1	7,1	9,0	2,7	2,5	2,9	3,9	6,4	5,4	5,9	7,0	8,1	8,0	4,9	2,2	9,1	16,1	11,6
Household Appliances	4,9	3,3	12,1	7,5	1,8	0,6	0,4	0,7	1,3	1,8	1,9	0,9	1,0	1,3	1,0	5,5	0,8	0,6	0,8	0,5
Other Electronics	23,2	22,7	15,7	10,6	11,0	25,4	13,8	14,3	7,2	12,8	7,3	10,9	14,4	6,6	7,7	5,1	2,3	1,2	1,8	0,8
Total Electronics Trade	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

USA

% Composition of Imports

	versus Taiwan					versus South Korea					versus Hong Kong					versus Singapore				
	1980	**1985**	**1988**	**1990**	**1993**	**1980**	**1985**	**1988**	**1990**	**1993**	**1980**	**1985**	**1988**	**1990**	**1993**	**1980**	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	1,7	8,8	15,6	52,1	61,9	3,0	1,9	4,4	23,5	30,6	15,9	23,0	15,6	31,2	35,4	0,7	34,8	46,0	61,9	71,7
Office Equipment	3,5	3,4	4,3	3,7	2,5	2,5	2,1	2,1	1,6	0,8	7,0	2,0	5,1	5,1	4,3	3,4	1,8	2,0	1,9	1,4
Telecommunication	2,1	5,5	4,7	3,6	2,8	0,6	4,4	4,4	3,3	1,7	0,3	4,4	6,7	3,5	3,2	0,3	1,0	3,7	1,4	0,4
Electronic Components	11,9	9,5	11,9	13,1	17,5	33,5	21,4	25,5	33,3	35,6	11,0	6,5	9,3	11,8	23,6	52,8	24,9	18,9	16,6	14,8
Consumer Electronics	56,9	30,1	19,8	11,8	5,6	52,0	37,7	30,7	26,0	21,9	47,4	41,6	33,8	30,6	23,1	16,5	14,8	11,3	9,7	7,3
Household Appliances	3,5	6,4	7,4	7,9	5,0	2,8	11,6	9,6	6,6	4,6	15,2	13,8	9,5	6,7	3,5	4,8	6,1	2,2	1,5	1,1
Other Electronics	20,4	36,2	36,2	7,7	4,6	5,5	20,9	23,4	5,8	4,8	3,3	8,8	20,0	11,1	7,0					
Total Electronics Trade	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Other Electronics	13,9	10,7	8,4	3,8	2,8	21,4	16,6	15,9	7,2	3,3
Total Electronics Trade	100	100	100	100	100	100	100	100	100	100

TABLE 5 (continued)

Electronics : U.S. Bilateral Trade Composition with EAST ASIAN Countries

(in percentage, Total Electronics Trade = 100)

USA

% Composition of Exports

	versus Malaysia				
	1980	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	4,4	3,1	2,9	5,5	8,3
Office Equipment	1,0	0,1	0,1	0,3	0,1
Telecommunication	1,5	0,7	1,0	0,8	1,4
Electronic Components	87,1	92,8	93,7	90,9	83,0
Consumer Electronics	1,2	0,3	0,2	0,5	3,4
Household Appliances	0,8	0,1	0,1	0,2	0,1
Other Electronics	3,9	2,9	2,1	1,8	3,5
Total Electronics Trade	100	100	100	100	100

	versus Thailand				
	1980	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	14,3	12,8	8,5	12,5	20,1
Office Equipment	3,7	2,4	0,3	0,8	0,3
Telecommunication	4,2	1,4	2,7	1,8	4,1
Electronic Components	43,3	63,6	79,9	67,1	52,1
Consumer Electronics	3,1	2,0	0,8	9,1	13,4
Household Appliances	4,2	0,5	0,6	0,7	1,3
Other Electronics	27,2	17,3	7,3	7,9	8,7
Total Electronics Trade	100	100	100	100	100

	versus China				
	1980	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	70,5	61,4	48,9	49,3	24,3
Office Equipment	4,6	1,3	0,7	1,9	1,4
Telecommunication	3,6	1,7	8,4	8,2	20,6
Electronic Components	2,9	3,1	2,3	12,1	1,8
Consumer Electronics	8,9	4,8	3,8	6,7	5,5
Household Appliances	0,2	0,3	1,0	0,9	0,7
Other Electronics	9,3	27,5	34,8	20,8	45,7
Total Electronics Trade	100	100	100	100	100

USA

% Composition of Imports

	versus Malaysia				
	1980	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	0,1	2,6	0,5	5,2	19,6
Office Equipment	0,0	0,0	0,1	1,3	1,4
Telecommunication	0,0	0,9	0,6	6,6	4,1
Electronic Components	93,5	80,4	75,1	53,0	38,0
Consumer Electronics	0,9	8,5	15,5	27,3	30,9
Household Appliances	0,0	1,0	0,2	0,1	0,8
Other Electronics	5,4	6,7	7,9	6,5	5,0
Total Electronics Trade	100	100	100	100	100

	versus Thailand				
	1980	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	0,0	3,0	38,9	32,4	41,5
Office Equipment	0,0	0,1	0,0	1,6	6,2
Telecommunication	0,0	0,2	0,5	7,3	9,3
Electronic Components	99,8	83,4	51,2	24,8	17,1
Consumer Electronics	0,2	0,2	2,5	23,3	16,5
Household Appliances	0,0	0,1	3,4	7,6	6,1
Other Electronics	0,0	13,0	3,6	3,0	3,3
Total Electronics Trade	100	100	100	100	100

	versus China				
	1980	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	3,6	0,9	1,4	2,7	16,6
Office Equipment	0,3	2,3	2,1	3,1	3,6
Telecommunication	0,0	5,3	8,3	13,0	6,4
Electronic Components	20,0	1,2	0,2	0,2	0,4
Consumer Electronics	57,2	63,0	47,6	43,8	39,6
Household Appliances	17,0	23,3	34,7	30,5	22,3
Other Electronics	1,9	4,0	5,6	6,6	11,1
Total Electronics Trade	100	100	100	100	100

Source: UN and OECD trade data, from SIE World Trade Data Base

TABLE 6

ELECTRONICS: Trade composition of East Asian Countries

(in percentage %, Total Electronics Trade = 100)

SINGAPORE

	IMPORT				EXPORT			
	1980	**1985**	**1989**	**1993**	**1980**	**1985**	**1989**	**1993**
Electronic Data Processing	5,91	20,15	26,18	27,76	1,95	28,44	41,33	48,80
Office Equipment	3,52	2,93	2,11	2,16	3,60	2,64	2,41	1,90
Telecommunication	3,08	2,14	2,27	3,10	1,38	1,02	1,77	1,78
Electronic Components	46,42	40,61	32,90	34,34	40,62	29,99	19,69	19,16
Consumer Electronics	30,31	23,81	27,08	24,82	39,26	25,09	24,80	20,23
Household Appliances	3,22	2,99	1,74	1,30	3,98	4,37	2,10	1,35
Other Electronics	7,55	7,37	7,73	6,51	9,20	8,45	7,91	6,78
Total Electronics Trade	100	100	100	100	100	100	100	100

SOUTH KOREA

	1980	**1985**	**1989**	**1993**	**1980**	**1985**	**1989**	**1993**
Electronic Data Processing	11,68	17,27	19,72	17,29	3,18	13,49	17,50	16,72
Office Equipment	2,81	4,44	4,78	4,29	1,81	1,05	1,23	0,86
Telecommunication	9,10	7,70	3,18	1,98	1,27	4,34	3,42	3,35
Electronic Components	43,13	46,03	54,75	55,54	27,87	23,78	27,78	36,73
Consumer Electronics	16,96	11,34	10,63	10,24	57,48	44,87	37,60	28,69
Household Appliances	3,99	3,39	1,31	1,35	3,65	7,59	7,47	6,24
Other Electronics	12,33	9,84	5,63	9,32	4,73	4,88	5,00	7,40
Total Electronics Trade	100	100	100	100	100	100	100	100

TAIWAN

	1980	**1985**	**1989**	**1993**	**1980**	**1985**	**1989**	**1993**
Electronic Data Processing	11,18	18,51	18,40	17,44	2,07	15,43	46,33	54,59
Office Equipment	2,94	2,98	2,70	2,16	3,93	3,90	4,39	1,76
Telecommunication	11,46	6,62	5,46	2,98	1,65	4,90	4,24	4,40
Electronic Components	30,07	40,44	45,65	59,00	16,10	14,33	12,79	22,99
Consumer Electronics	20,41	12,62	15,62	10,54	55,43	28,13	18,04	7,03
Household Appliances	3,51	3,45	6,16	2,78	2,72	5,39	7,77	3,75
Other Electronics	20,42	15,39	6,00	5,09	18,11	27,94	6,44	5,47
Total Electronics Trade	100	100	100	100	100	100	100	100

HONG KONG

	1980	**1985**	**1989**	**1993**	**1980**	**1985**	**1989**	**1993**
Electronic Data Processing	14,77	15,40	11,99	13,86	9,20	17,80	16,10	18,21
Office Equipment	4,37	6,38	3,56	3,05	3,31	4,43	3,96	3,71
Telecommunication	4,13	3,20	4,97	4,31	0,32	3,92	5,05	4,71
Electronic Components	25,26	24,20	25,35	24,51	12,87	12,80	15,10	14,03
Consumer Electronics	40,70	36,79	40,02	35,58	60,75	39,43	39,90	37,88
Household Appliances	5,81	7,20	7,10	7,10	9,97	12,21	9,58	9,20
Other Electronics	4,94	6,83	7,02	11,58	3,57	9,41	10,31	12,25
Total Electronics Trade	100	100	100	100	100	100	100	100

TABLE 6 (continued)

ELECTRONICS: Trade composition of East Asian Countries

(in percentage %, Total Electronics Trade = 100)

THAILAND

	IMPORT				EXPORT			
	1980	**1985**	**1989**	**1993**	**1980**	**1985**	**1989**	**1993**
Electronic Data Processing	3,37	17,44	35,02	27,47	0,52	4,46	40,72	35,70
Office Equipment	13,69	21,74	2,06	2,47	21,76	80,69	1,03	4,78
Telecommunication	22,14	12,91	6,79	6,74	2,15	0,12	3,28	5,18
Electronic Components	12,75	2,80	33,76	38,56	0,06	0,45	28,39	23,26
Consumer Electronics	14,07	11,80	10,35	12,42	57,74	7,21	16,97	21,33
Household Appliances	11,68	4,87	3,23	2,08	10,85	2,44	8,15	6,48
Other Electronics	22,29	28,45	8,80	10,24	6,92	4,62	1,46	3,27
Total Electronics Trade	100	100	100	100	100	100	100	100

MALAYSIA

	1980	**1985**	**1989**	**1993**	**1980**	**1985**	**1989**	**1993**
Electronic Data Processing	2,40	5,91	8,37	11,97	0,04	1,08	3,23	17,54
Office Equipment	2,31	1,34	1,03	0,76	0,11	0,10	0,61	1,35
Telecommunication	6,26	8,91	2,90	2,35	0,24	0,63	2,12	3,41
Electronic Components	69,59	67,54	67,18	61,72	91,22	80,69	59,44	39,90
Consumer Electronics	11,67	9,89	10,19	11,83	4,58	11,41	27,33	31,45
Household Appliances	2,77	1,93	1,08	1,15	0,47	0,98	0,50	0,99
Other Electronics	5,00	4,47	9,25	10,23	3,33	5,11	6,77	5,36
Total Electronics Trade	100	100	100	100	100	100	100	100

CHINA

	1980	**1985**	**1989**	**1993**	**1980**	**1985**	**1989**	**1993**
Electronic Data Processing	16,68	14,70	15,28	15,48	1,30	6,67	3,87	14,88
Office Equipment	4,53	6,50	2,40	2,25	4,23	4,35	3,59	3,73
Telecommunication	1,72	4,04	12,00	23,19	0,68	4,65	7,11	6,07
Electronic Components	3,57	5,09	8,57	18,30	1,81	1,89	0,79	3,04
Consumer Electronics	60,69	43,69	29,80	15,85	46,32	61,94	58,56	49,53
Household Appliances	2,61	9,95	6,69	2,72	27,69	14,48	20,97	14,66
Other Electronics	10,19	16,03	25,25	22,20	17,96	6,01	5,11	8,08
Total Electronics Trade	100	100	100	100	100	100	100	100

Source: UN and OECD trade data, from SIE World Trade Data Base

Tables 5 and 6 provide clear evidence that, since around 1988, all of these countries have gone through a progressive integration into a variety of IPN. The composition of bilateral US exports and imports with East Asia obviously reflects the development of a regional supply base by American producers of semiconductors and PC-related products. This however is only part of the story. We also find evidence for trade effects resulting from the spread of other IPN, such as those established by consumer electronics companies from Japan and Korea, and those established by Taiwanese computer companies.

On the export side, the growing share of EDP and components results from the expansion of export-oriented IPN of American computer firms in Asia. This involves final assembly activities of equity-owned affiliates as well as the spread of a variety of inter-firm supplier networks that range from OEM to turnkey production arrangements. US computer companies now also pursue aggressive strategies to penetrate some of the important new growth markets in East Asia. The story is more complicated for U.S. imports. To some degree, they result from increasing sales of subsidiaries of American companies and related suppliers back to the U.S. Increasingly, however, they also reflect the spread of Japanese IPN in Asia and the substantially improved competitiveness of some Korean and Taiwanese firms.

In what follows, we will discuss our findings in more detail and demonstrate how the spread of diverse IPN has shaped the composition of bilateral trade links between the US and East Asia.

3.1 US trade links with Singapore

We start with Singapore which, like no other country in the region has attracted international production activities of American computer and disk drive manufacturers. By the early 1980s when American firms decided to move to Singapore, low labor costs were not the primary concern. The real decisive factor was the strength of its infrastructure and support industries required for the manufacture of key components[2222222222222].

[2222222222222] Take the case of Seagate, a leading US producer of hard disk drives (HDDs). In 1982, when it chose Singapore as the final assembly place of HDDs, it was one of the few locations in Asia that already had in place a critical mass of support industries.

Three factors were responsible for the existence of such support industries in Singapore: 1) Singapore's earlier prominent role as a offshore production site for cameras and optical equipment, which led to the development of precision mechanical engineering capabilities; 2) the existence of sophisticated government policies to promote local support industries; and 3) the pioneering role that an American company, founded by an Indian with a Singaporean passport, has played in establishing Singapore as an offshore production site for FDDs since the late 1970s. This company, named Tandon, has been one of the leading suppliers of FDDs, before it went out of business. (Ernst, 1996)

In the meantime, Singapore has lost whatever cost advantage it may once have possessed. Nevertheless, it is still attracting massive investments by major American computer and disk drive companies. In the disk drive industry, for instance, two main reasons seem to explain the continuous attraction of Singapore: (i) Singapore has accumulated important locational advantages, in terms of a first-class labor force that knows the disk drive industry inside out and that is plugged into the necessary information circuits; (ii) all major PC producers have shifted a large part of their production to this region, with the result that Asia is now the most important market for the HDD industry[22222222222222]. Due to its central location and its excellent infrastructure and support industries, Singapore is thus well qualified to become the regional engineering and coordination center for the East Asian HDD industry.

How has this affected the trade composition of Singapore's electronics trade? First, the composition of Singapore's electronics exports (see Table 6) experienced radical change over the last decade: back in the 1980, electronic components (with almost 41%) and CE (with 39%) were responsible for 80% of these exports, while by the early 1990s EDP has become by far the most important export group (almost 50%). The second imprtant development is that the composition of electronic components exported by Singapore has also drastically changed, from inputs mostly dedicated for the consumer electronics industry to shipments of parts and subassemblies to final assembly locations within East Asia for EDP related products. This is reflected in our trade figures. While, in 1993, more than 19% of Singapore's electronics exports were components, their share was much higher for Singapore's intra regional exports (42% for Malaysia, and 25% for Thailand)[222222222222222].

Singapore electronics imports also clearly documents the importance of its integration into the IPN of American computer firms. Already since 1985, both electronics components and EDP were by far the most important import products and have been increasing their role during the last decade. These findings are matched by data on US trade links with Singapore that show how US exports to Singapore overwhelmingly have consisted of components and EDP(their combined share was 82% in 1993). EDP has played a particularly important role for US imports from this country: its share has consistently increased from 46% in 1988 to almost 72% in 1993.US trade links with Singapore thus primarily have been shaped by the prominent role that this country plays for the

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[22222222222222] Take again the example of Seagate. Over time, this company has developed a quite articulate regional division of labor in East Asia. Bottom-end work is done in Indonesia. Malaysian and Thai plants make components and specialize in partial assembly. Singapore is the centre of gravity of this regional production network: its focus is on higher-end products and some important coordination and support functions. It completes the regional production network, by adding testing, which requires precision.

[222222222222222] We get an even better idea of Singapore crucial role as a regional production hub and coordination center for the Asian IPN of American computer firms, when we look at the combined share of EDP and components in Singapore intra-regional exports: in 1993, this share for Malaysia exceeded 57%, while in Thailand it was as high as 61%.

IPN of US computer and disk drive firms.

US trade links with Malaysia and Thailand

Malaysia is the country, where US exports display the greatest share of product concentration. No other country in the region comes close to the 83% share of components in US exports to Malaysia (Table 5). What are the reasons for such a high share?
Since the early 1970s, Malaysia has been a favorite offshore assembly location for US semiconductor firms. After 1990, Malaysia also became an important location for US disk drive manufacturers. Both developments are well reflected in the product composition of Malaysia's exports : Components continuously were the largest export category in Malaysia, despite the fact that their share in Malaysian exports declined from more than 91% in 1980 to less than 40% in 1993. At the same time, the share of EDP in Malaysian exports has increased from a meagre 3% in 1989 to almost 18% in 1993. One can conclude that US component exports to Malayisa have served primarily as inputs to the final assembly and testing of ICs as well as of hard disk drives. Almost all of these ICs and HDDs are then exported, either to the US or to US production affiliates in Asia and Europe. The extraordinarily high share of components in US exports to this country thus results from Malaysia's integration into the IPN of US semiconductor and disk drive manufacturers.

On the other hand, Malaysia stands out as a case where two different types of IPN affect US electronics imports. Electronics components, while declining, still constitute the most important import product which reflects the impact of the early investment of US semiconductor firms in this country. At the same time, however, CE has rapidly increased in importance and now constitutes the second largest import category of US imports from Malaysia. This is a result of the massive shift of Japanese CE manufacturers from Japan to Malaysia since around 1986, and the fact that sales of Japanese CE products in the US now increasingly originate from transplants established in Malaysia and elsewhere in the region.

US trade links with Thailand (Table 5) also reflect the country's integration into two different IPN: those established by US HDD producers that have branched out from Singapore to lower-cost production sites within the region; and those established by Japanese producers of CE and appliances that have rapidly expanded their production activities in this country after 1986. We can discern the impact of the first type of IPN from the following figures. More than 52% of US exports to Thailand consist of electronic components. While the share of components has declined quite drastically from the almost 80% reported for 1988, the share of EDP has rapidly increased from less than 9% to more than 20%. After 1990, when most of the above investments of US HDD firms went on stream, there has been a substantial increase in the share of EDP in US imports from slightly more than 32% to almost 42%.

3.3. U.S. trade links with Korea and Taiwan

U.S. trade links with Taiwan and Korea reflect a different and more sophisticated type of integration into IPNs. In both countries, foreign firms, both from the U.S. and Japan, have played an important catalytic role for the development of electronics industry. Yet, starting from the 1980s, domestic companies have clearly played a decisive role, by accumulating a critical mass of technological and organizational capabilities that, today, enable them to move beyond a role as junior partners of American and Japanese firms. The formation of this capability that affected trade specialization of both countries should thus be considered in analyzing trade links with the U.S.

Let us first look at Taiwan. In the elecronics industry, this country has achieved an extreme trade specialization. Both its exports and imports are dominated by just one product group: EDP is responsible for nearly 55% of exports, while nearly 60% of Taiwan's imports are electronic components (Table 6). Over the last decade, Taiwan has established itself as a world-class supply source for a variety of electronic hardware products and more recently it has become the world's largest manufacturer of notebook PC, developing also a strong position in the semiconductor industry. These are impressive achievements. Yet the rapid expansion of Taiwan's PC industry has come at a heavy cost, in terms of rapidly growing component imports (almost 60% of electronics imports are absorbed by electronic components). The rapid expansion of production capacity and international market share for PC-related products has not been matched by industrial deepening, i.e. the spread of backward and forward linkages. For most of the key components that determine the price and the performance features of its major export products, Taiwan continues to rely heavily on imports, primarily from Japan[222222222222222]. There are however also encouraging signs. If we look at Taiwan's exports, we see that, since 1992, a quantum jup has occurred in the share of components (from less than 14% to almost 23%), which clearly constitutes an impressive improvement.

Let us now look at the changes in the product composition of U.S. electronics trade with Taiwan (Table 5) . Components are by far the most important product group of US electronics exports to this country: their share has consistently increased since 1985 from more than 31% to almost 56%. Most of these components are semiconductors that are shipped to Taiwan as inputs to its burgeoning PC industry. The growing share of components in US exports to Taiwan thus reflects the increasing importance of Taiwan as a global supply base for the world PC industry that we have described before. EDP is the second most important product group of US electronics exports to Taiwan. Yet, at less than 18%, its share remains well below the more than 41% share that EDP

[222222222222222] Take CRT- picture tubes for computer monitors. Taiwan's success in this industry has come at a very heavy cost: nearly 2/3 of the CRTs that go into these monitors have to be imported, either from Japan or from Japanese affiliates in Southeast Asia. The situation is equally severe for integrated circuits and liquid crystall displays. Ernst, 1997b

has in US electronics exports in general. Of equal importance is that the share of EDP, since 1985, has continuously declined.

Taiwan's leading position as an international supply base for the PC industry becomes even more obvious, when we look at the product composition of US imports: 62% of these imports consist of EDP, with more than 17% in addition consisting of components. This reflects a drastic change in the product composition over the last eight years. In 1985, CE and appliances were responsible for almost 40% of US imports from Taiwan. In 1988, the combined share of EDP and components (28%) for the first time surpassed the combined share of CE and appliances (27%). In 1990, EDP plus components have increased their share to 65%, which, since then, has exploded to almost 80%. While still lagging behind Singapore, Taiwan has been able to increase very rapidly the share of EDP in US imports: from less than 9% in 1985, it increased to 52% in 1990 and almost 62% in 1993. Electronic components also have increased their share in US imports. Yet, at slightly more than 17%, this share still remains well below the more than 27% share that components occupy in US electronics imports in general.

In the case of Korea, one important feature of its electronic industry is the very high dependence on imports of key components, mostly from Japan and the US(nearly 56% of its imports are electronic components).As for its exports, two product groups - consumer electronics and electronics components - have traditionally dominated (Table 6). They continue to dominate today, with the important difference however that, since 1992, electronics components have overtaken CE as the leading export category[222222222222222]

The second noteworthy feature of Korea's export strucutre is its truncated shift towards industrial electronics (EDP, telecommunication equipment, industrial automation and control system), despite a serious effort made by the Korea's government to achieve this goal. Since the late 1980s, after an initial increase, the combined share of industrial electronics has stagnated and has covered around a ceiling of 22% for production and 21% for exports. Korean electronics industry thus still remains confined to fairly traditional mass production activities of standard commodities and has by and large failed to become a serious competitor for computer-related products and telecommunication equipment.

How has this affected the product composition of U.S. electronics trade with this country? US trade links with South Korea share some of the features that we have just described for Taiwan,

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[222222222222222] Korea's component exports are dominated by computer memories, especially DRAMs, which are characterized by extremely high investment tresholds and very demanding process technology. This clearly indicates a substantial improvement in the production capabilities and in the financial power of the leading Korean electronics corporations which are now able to compete head-on with the Japanese market leaders. (Ernst, 1997c)

which reflects the relatively advanced stage of the electronics industry in both countries. With a share of more than 50%, components again dominate US exports. The share of EDP in US exports to Korea is considerably higher than for Taiwan, yet it remains well below the more than 41% share that EDP has in US exports in general.

Important differences however exist on the import side. Only a few years ago, CE and appliances were the most important product groups. In 1985, their combined share in US imports was close to 50%. Since then, however their share has rapidly fallen to around 40% in 1988, less than 33% in 1990 , and less than 27% in 1993. Today, components dominate US imports from Korea, with a share of almost 36%. With the exception of Malaysia, this is the highest share of any East Asian country. Korea however differs substantially from Malaysia: while Malaysia relies primarily on the final assembly of imported semiconductors, Korea's component exports primarily consist of memory devices, mostly DRAMs, whose production is fully integrated and thus also includes wafer fabrication. Malaysia remains an offshore chip assembly site, wheras Korean semiconductor firms are able to compete on their own in the worldwide semiconductor market[222222222222222].

The second most important category of US imports from Korea are computer-related products: their share in US imports has increased quite rapidly from less than 5% in 1988 to almost 31% in 1993. Korean firms have not been able to develop a strong position as suppliers of original brand name PCs. Most of their EDP sales to the US consist of OEM contracts for PCs and related peripheral equipment, especially monitors. In other words, for EDP, Korea acts as a secondary supply base for US computer firms, yet it keeps trailing well behind both Taiwan and Singapore. For most PC-related products thus Korean firms have failed to become important competitors on their own.

3.4 U.S. trade links with China

Finally, turning to China, we can see that China's electronics exports consistently have been dominated by two product groups: CE and household appliances (Table 6). The combined export share of both products reached a peak of 80% in 1989, and has fallen since then to roughly 64% in 1993. No other country in the region displays such a high share of appliances in its exports. This is due, in our view, to two reasons: (i) no other country can match the size of China's domestic market growth potential for household appliances; (ii) the still very low level of development of China's electronics industry that is still concentrated in the Southern coastal provinces, and mostly confined to final assembly processes with limited local value-added.

222222222222222 Ernst, 1994 b, chapter 4.

A second important feature of China's export structure is that, since 1990, the share of EDP has increased at a very rapid pace: it doubled from less tha 6% to nearly 12% between 1990 and 1992, and increased further to almost 15% in 1993. To a large degree this is a reflection of the rapid expansion of Taiwanese IPN in China for the production of many PC-related products.
As to the product composition of U.S. trade links with China in the electronics industry, rpobably the most important feature is that CE and appliances dominate US imports from this country (Table 5). While the combined share of both products in US imports declined from 83% in 1988 to 62% in 1993, both import categories have substianlly increased in absolute terms. Most of these imported CE and appliances de facto constitute sales of production affiliates that Japanese as well as Korean CE producers have established in China over the last few years. A large, albeit declining share of US imports from China thus result from the expansion of Japanese and Korean IPN into China.

It is also important to note that EDP has drastically increased its share in US imports: from 1% in 1988, this share has increased to 17% in 1993. Most of these imports are sales of foreign affiliates that Taiwanese OEM suppliers and US computer firms have established in China over the last few years.

As for US exports to China, we find three noteworhty developments: 1) a drastic decline in the share of EDP from more than 49% in 1992 to less than 25% in 1993; 2) a rapid increase in the share of telecommunications equipment from 8.2% to almost 21%; and 3) a doubling in the share of orther electronics from less than 21% in 1992 to almost 46% in 1993.

The declining share of EDP in US exports, in our view, results from the spread of overseas production facilities of US computer firms in China, whose main purpose is to sell to the Chinese market. In this case, the spread of IPN of US computer firms has led to a considerable substitution of imports from the US. The Chinese market for telecommunications equipment is currently one of the most attractive markets worldwide. The increasing share of telecommunications in US exports result from the successful market penetration strategies by Motorola and AT&T.

Finally, we are hard pressed to explain the increasing share of other electronics in US exports to China. One possible explanation could be that a number of other components, like for instance connectors, are part of this product group. In connectors, US firms like AMP are still market leaders, despite successful catching-up strategies of Taiwanese firms. They may have increased their investment in China, in order to fight back the attack by Taiwanese firms. But we need further in-depth research in order to support this hypothesis.

To sum up, since 1980, East Asia has consistently been a critical source of US electronics imports. Reflecting the first round of US offshore assembly investments, this region was the most important source in 1980, ahead of Japan. In terms of product groups, apart from CE, the US has imported

a growing share of EDP from East Asia: in 1993, almost 50% of all US EDP came form East Asia.

This clearly indicates that East Asia has now become a critical supply base for the US computer industry. In this industry, East Asia is of much greater importance for the US than for Japan. U.S. trade links with East Asian countries thus have been significantly shaped by the different roles that East Asian countries play for the international production networks of American and other global competitor firms.

4. Japan`s trade links with East Asia: the nexus with international production networks

4.1 The great variety of trade links in electronics

Compared to the US, Japan's trade links with East Asia display a greater variety. This applies to the product composition as well as to the role played by different countries in the region (Table 7). This greater diversity, we argue, results from some peculiar features of the IPN that Japanese firms have developed in East Asia that have prevailed until the very 1990s.

In the organization of international production in East Asia, Japan electronics firms have taken a very different approach from American companies[222222222222222]: they started out much earlier than US firms with overseas production in East Asia; Japanese firms focused on very different product groups and markets than American firms, i.e. consumer electronics (CE) and household appliances; domestic market-oriented, rent-seeking production rather than export platform production remained the dominat concern until the mid-1980s; and once Japanese firms shifted to export platform production, they have tried to keep their IPN as closed as possible to outsiders, by centralizing almost all strategic decision-making and high value-added activities in Japan.

The closed IPN gave rise to an asymmetric trade and investment relationship between Japan and East Asia, leading to the emrgence of serious regional trade imbalances. Only very recently have Japanese firms begun to gradually open their IPN, which has led to an increasing localization of component sourcing in Asia, plus increasing exports of production equipment from Japan. At the same time, Japanese electronics firms have now also begun to broaden the product mix that they produce in Asia to include a variety of PC-related and telecommunications equipment products.

This has had important implications for Japan's trade links with East Asia. Japanese electronics exports to the region share one common feature with US electronics exports to East Asia: the dominance of electronic components. More than 61% of Japanese exports to Taiwan and Korea are components, nearly 59% for Malaysia, and between 44% and 43% for Thailand and Singapore. The share of components is much lower for Hong Kong (32% in 1993), while for China, it has fallen from slightly above 12% in 1990 to less than 7% in 1993. Overall, however, components play a less prominent role for Japanese exports than for US exports. Other product groups, like EDP, office equipment and CE are also important.

On the other hand we find that Japanese exports to the region have experienced great changes over the last one and half decade. This is because up to the first half of the 1980s, Japanese

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[222222222222222] Ernst, 1997a

electronics firms have predominantly relied on exports rather than on international production to generate sales in the region. Since the mid-1980s however, this pattern begins to change. Offshore production of Japanese subsidiaries in East Asia expands at a rapid pace, with the result that the share of exports in sales to the region begins to decline. Almost all of this Asian production activities relate to a variety of consumer products and related componets. It is also important to note that, within East Asia, these production activities have been heavily concentrated in geographical terms.[222222222222222]

As to Japan's electronics imports from the region, we find that in absolute terms they are still much lower than North America's and Europe's imports from the region. Yet, important changes have occurred since around 1992: Japan's imports of electronics products are now growing very rapidly, and Asia has become the most important source of these imports. The share of imports from Asia have surged from less than 31% (Y384.6 billion) in 1988 to more than 44% (Y 962 billion) in 1993. Foreign imports account for a larger portion of domestic demand, resulting in a significant rise in Japan's import ratio for electronics from 10.3% in 1985 to an estimated17.5% in 1993. The most rapid increase has occurred for electronic components, where the import ratio shot up from 16% in 1985 to more than 35% in 1993. While in 1988, the US was the only source of imported ICs and computers, today Japan imports roughly the same amount of ICs and computers from Asia and from the US. Japan's import ratio has also increased for CE and household appliances: from 2.1% in 1985, it has risen almost fivefold to 10.2% in 1993. That still constitutes however a quite low domestic market penetration.

Apart from drastic changes in the product composition, we also find that Japanese imports from East Asia are much more diverse than US imports. On the one hand, there is a group of four countries where one product group dominates Japanese imports: EDP for Singapore (almost 62% of Japanese imports); CE and appliances for China (their combined share of Japanese imports is 60%); components for Korea (48%); and CE plus appliances for Hong Kong (their combined share accounts for 45% of Japanese imports). For each of these four countries, one product group thus defines the role that this country plays as a supply base for Japanese firms.

For the remaining three countries, Japanese imports consist of widely different product mixes. For Taiwan, components (34% of Japan imports) and EDP (almost 33%) together account for 67% of Japanese imports. For Malaysia, CE accounts for more than 37%, yet EDP (almost 22%) and components (slightly more than 21%) also account for significant shares. Finally, for Thailand, EDP is the leading Japanese import category (with 37%), followed by EC (24%) and components

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222222222222222 In 1993, 60% of the overseas affiliates of Japanese electronics firms were located in Asia. Out of these, two third were located in just four countries: Malaysia (24%), Taiwan (17%), Singapore (13%), and Thailand (12%). This concentration was even higher in terms of the labor force. (Ernst, 1996a)

(14%).

What causes these highly divergent product compositions? The short answer is: the export specialization of different countries. So are we back to the theory of comparative advantages? We argue that this is not the case for two reasons: First, these export specializations are created and did not result from market forces, second, they have been decisively amplified through participation in international production networks. The existence of different, and sometimes competing IPN has broadened the options available to Asian economies. Depending on which products dominate their production and exports, they have been integrated into different IPN. We find that the composition of Japanese trade with East Asia reflects the spread of IPN that Japanese producers of consumer electronics and of related components have established in the region. Asia has been able to strengthen its role as supply base for electronic components and PC-related products. While in 1988, the US was the only source of imported ICs and computers, today Japan import roughly the same amount of ICs and computers from Asia and from U.S. Furthermore, like in the case of the U.S. before, we also find evidence of trade effects resulting from the spread of other IPN. In the case of Japan, this include production networks established by consumer electronics companies from Korea, and those established by American computer companies and, more recently, Taiwanese computer companies.

4.2. The trade links between Japan and East Asia in consumer electronics and computer related-products

Let us first look at CE and appliances, the traditional focus of Asian production activities of Japanese electronics firms. Asia’s share in Japanese electronics imports is extremely high for CE and appliances: in 1993, this share was close to 84%. Most of these imports originate from Japanese transplants in Malaysia, Thailand and China. Take for instance the import of Japan from Malaysia which show that since 1985, the share of CE has drastically increased from 2% to almost 38% in 1993. This last figure is well above the share of CE in total Japanese electronics imports (20% in 1993). This indicates that Malaysia has now become an important supply base for Japanese CE producers.

For these products, Japan's trade links with East Asia are dominated by intra-firm trade, and the spread of Japanese IPN has obviously played an important role. MITI data on the shares of intra-firm trade in the sales and purchases of Asian affiliates of Japanese electronics firms provide some striking evidence . In FY 1992, when most of these affiliates were still primarily engaged in the production of CE and appliances plus related components, we find an overwhelming reliance on intra-firm trade: 90% of the affiliates' sales to Japan were intra-firm sales, while for purchases this share was nearly 85%. At least for consumer electronics, it is safe to conclude that East Asia's

trade integration with Japan has been shaped by the spread of Japanese IPN. It is equally safe to conclude that most of the sales and purchases that result from Japanese production activities in this region have remained confined to relatively closed intra-firm or intra-group production networks.

The situation is very different however for computer-related products. Take for instance the case of Taiwan which has experienced a dramatic growth of Japanese EDP-related imports. From less than NT$ 3.9 billion in 1990, these imports have increased to more than NT$ 21 billion in 1994. The share of components in Japanese exports to this country has also drastically increased since 1990, when the Taiwanese PC industry began to take off: within three years, it increased from 48% to almost 62% of Japanese electronics exports. On the import side of Japan we find that two products predominate in 1993: components with 34% and EDP with almost 33%. Together they account for more than two third of Japanese imports from Taiwan. Especially impressive is the rise reported of these imports in the last two years: Taiwanese exports to Japan have increased by 347% for PC´s, 169% for components, 122% for terminals, and 110% for monitors[222222222222222]. Equally impressive are the reductions in Taiwan's imports from Japan during the same period: -36% for components and -35% for other peripherals.

This increase of Japan's imports from Taiwan is driven by two developments: (i) In response to the successful penetration of the Japanese PC market by American PC manufacturers, Japanese PC manufacturers have drastically increased their OEM/ODM purchases from Taiwanese computer companies; (ii) Japanese PC manufacturers have also rapidly expanded their purchases of a variety of PC-related components from Taiwanese firms.

Taiwanese companies today dominate the world market for many of these products. What matters however is that an increasing share of these products is now produced overseas, primarily in Asia. Under tremendous competitive pressure, Taiwanese computer companies did not have much choice but to engage in an incredibly fast expansion of overseas production. Between 1992 and 1994, the overseas production of Taiwanese computer firms more than tripled, from around $ 970 million to more than $ 3 billion[222222222222222]. ASEAN countries and China have attracted most of

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222222222222222 Figures provided by the Market Intelligence Centre at the Institute of the Information Industry, Taipei, Taiwan

222222222222222 Over time, important changes have occurred in the motivations. A first wave of overseas production was driven primarily by defensive investments of small-and medium-sized producers of labor-intensive products (like keyboards and computer mouse). The main motivation was to cope with the severe price reduction pressures of their foreign OEM clients. Overseas production, for these firms, was the only way to survive the appreciation of the NT-dollar, and the spiralling land costs and severe labor shortages in Taiwan. Investing in mainland China with its lack of investment regulations seemed to offer an easy way out. Larger Taiwanese firms like Acer, Mitac and First International Computer (FIC) have entered the fray since 1992, when the Taiwanese government finally dropped earlier

these investments[222222222222222].

The result is that we are now dealing with increasingly complex forms of IPN. Taiwanese computer firms act primarily as OEM suppliers. Yet, at the same time, the Taiwanese production system for EDP has to be coordinated across national boundaries. Take a typical OEM contract between a Taiwanese PC manufacturer and a Japanese customer. Final assembly and shipping is done in Tawain, with the result that this OEM contract shows up as an increase of Japanese imports from Taiwan. Yet, many of the components and subassemblies are no longer produced in Taiwan and are in fact supplied by Taiwanese affiliates in China or in Southeast Asia. Japanese imports of EDP and components from East Asia may be fed from a variety of sources that belong to different IPN. Japanese firms certainly play an important role, but they are no longer an exclusive driving force. For computer-related products, it is thus difficult to deny that strategies of Taiwanese firms are now playing a crucial role for the shift to intra-regional trade in East Asia.

This small example clearly indicates that we have to be very careful in our conclusions on what are the driving forces behind the changes in the region's trade patterns: Japanese international production strategies matter, but they are certainly not the only force to be reckoned with. It is often claimed that the massive expansion of Japanese manufacturing FDI to East Asia has been the root cause for recent changes in East Asia's trade patterns, and especially for its much faster economic integration. Like all half-truths, this popular assertion can be misleading, if it would lead us to neglect the important role of international production networks established by electronics firms from the US, Europe, Korea and Taiwan. In the electronics industry, Japanese firms are not the only ones that have established international production networks in Asia. Nor have they always been the first . Japanese firms have clearly ceased to be the only carriers of Asian regionalization .

To sum up, despite its close proximity, East Asia has played a much less prominent role as a source of Japanese electronics imports than it did for the US. Until 1990, Japanese electronics

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restrictions to investments in China. Since then, these larger companies have rapidly increased their offshore production lines both in China and Southeast Asia, redeploying primarily large volume assembly lines for more scale-intensive products like monitors and motherboards. The source for this and the following note, is Ernst, 1997b.

222222222222222 For monitors, the share of offshore production has increased from 12.5 % in 1992, to 24% in 1993 to 40% last year. South East Asia accounts for roughly three quarters of the overseas production value, with China adding another 23%. For PC motherboards, the pace of expanding overseas production has been truly breath-taking: in 1994, overseas production grew by almost 90%. The share of overseas production in Taiwan's total sales of motherboards has increased from 26% in 1993 to more than 34% in 1994. As demand for these products keeps growing very rapidly, the main motivation for this type of investment has been to expand production capacities, especially for lower-end products, without having to shoulder the very high fixed capital cost burdens that are characteristic today for investments in Taiwan.

imports overwhelmingly originated from the US, and even in 1993, East Asia's share was significantly lower than that of the US. More recently, this pattern has begun to change and the role of East Asia as source of Japanese electronics has been rising.

On the other hand, fundamental differences exist in the logic of integration of American and Japanese companies with East Asia. For the US, the focus clearly is on computer -related products, while for Japan, until very recently, the focus overwhelmingly has been on consumer products.

TABLE 7

Electronics : JAPAN Bilateral Trade Composition with EAST ASIAN Countries

(in percentage, Total Electronics Trade = 100)

JAPAN

% Composition of Exports

	versus Taiwan				
	1980	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	5,4	13,3	16,3	18,5	15,8
Office Equipment	3,9	4,8	4,2	3,3	3,6
Telecommunication	6,9	3,0	4,0	4,2	2,4
Electronic Components	35,8	46,6	47,9	48,1	61,5
Consumer Electronics	26,9	17,5	20,1	17,2	9,4
Household Appliances	3,4	3,7	3,4	3,8	3,6
Other Electronics	17,7	11,1	4,1	4,9	3,7
Total Electronics Trade	100	100	100	100	100

	versus South Korea				
	1980	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	11,3	19,9	16,5	17,0	11,6
Office Equipment	3,4	3,2	3,7	5,7	9,3
Telecommunication	3,1	1,6	1,0	1,2	0,8
Electronic Components	35,3	42,6	54,4	55,6	61,2
Consumer Electronics	23,5	18,7	15,7	12,6	10,1
Household Appliances	3,0	0,8	1,1	1,0	1,0
Other Electronics	20,4	13,2	7,5	6,9	6,0
Total Electronics Trade	100	100	100	100	100

	versus Hong Kong				
	1980	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	3,7	7,3	13,3	14,2	10,9
Office Equipment	6,8	10,1	4,8	5,0	5,1
Telecommunication	0,8	3,2	7,0	5,1	3,4
Electronic Components	19,1	23,0	29,8	24,7	32,0
Consumer Electronics	58,8	45,5	34,1	38,0	33,0
Household Appliances	7,8	5,2	3,8	2,8	2,2
Other Electronics	3,0	5,7	7,2	10,3	13,3
Total Electronics Trade	100	100	100	100	100

	versus Singapore				
	1980	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	2,0	6,9	12,1	13,2	19,7
Office Equipment	5,6	6,0	3,2	3,3	4,0
Telecommunication	4,9	3,8	3,8	3,7	2,7
Electronic Components	16,9	27,9	36,9	35,4	43,3
Consumer Electronics	55,1	38,3	32,6	35,5	22,1
Household Appliances	6,1	6,4	2,7	1,4	1,1
Other Electronics	9,5	10,8	8,6	7,4	7,0
Total Electronics Trade	100	100	100	100	100

JAPAN

% Composition of Imports

	versus Taiwan				
	1980	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	4,1	17,0	11,5	17,8	32,7
Office Equipment	1,0	3,5	14,1	7,1	3,3
Telecommunication	1,5	3,0	7,4	8,3	3,1
Electronic Components	47,2	47,6	21,7	35,9	34,1
Consumer Electronics	33,4	17,2	30,4	15,7	14,6
Household Appliances	3,9	2,0	10,9	7,8	8,1
Other Electronics	8,9	9,8	4,1	7,5	4,1
Total Electronics Trade	100	100	100	100	100

	versus South Korea				
	1980	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	3,0	9,2	11,3	14,2	7,0
Office Equipment	5,2	2,1	2,1	2,3	1,2
Telecommunication	0,7	1,2	4,0	5,3	3,9
Electronic Components	40,7	34,8	24,0	28,7	48,0
Consumer Electronics	35,8	40,5	46,6	38,0	33,5
Household Appliances	0,3	0,9	4,7	4,7	3,1
Other Electronics	14,3	11,3	7,4	6,9	3,1
Total Electronics Trade	100	100	100	100	100

	versus Hong Kong				
	1980	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	7,9	19,8	23,8	29,2	35,2
Office Equipment	0,1	1,3	6,3	5,6	10,0
Telecommunication	0,1	3,8	3,2	7,6	1,7
Electronic Components	6,0	9,8	3,9	6,2	11,2
Consumer Electronics	80,0	58,6	53,4	38,7	39,2
Household Appliances	3,3	6,4	6,8	5,3	2,0
Other Electronics	2,6	0,3	2,5	7,3	0,7
Total Electronics Trade	100	100	100	100	100

	versus Singapore				
	1980	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	3,1	27,8	22,3	53,2	61,8
Office Equipment	5,6	0,0	0,8	0,2	0,2
Telecommunication	0,0	0,7	2,3	0,5	0,4
Electronic Components	42,2	34,8	8,6	12,3	19,0
Consumer Electronics	36,9	35,1	59,4	29,5	16,0
Household Appliances	9,1	0,9	1,2	0,2	0,3
Other Electronics	3,1	0,8	5,3	4,0	2,2
Total Electronics Trade	100	100	100	100	100

TABLE 7 (continued)

Electronics : JAPAN Bilateral Trade Composition with EAST ASIAN Countries

(in percentage, Total Electronics Trade = 100)

JAPAN

% Composition of Exports

	versus Malaysia				
	1980	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	1,7	3,3	3,5	7,0	6,8
Office Equipment	3,1	2,8	1,3	1,5	1,0
Telecommunication	7,2	12,0	1,8	4,7	5,0
Electronic Components	40,5	44,4	74,1	57,9	58,6
Consumer Electronics	28,9	22,2	11,5	17,4	20,8
Household Appliances	6,7	6,6	2,4	1,7	1,0
Other Electronics	11,9	8,6	5,4	9,8	6,7
Total Electronics Trade	100	100	100	100	100

	versus Thailand				
	1980	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	2,8	12,2	17,4	15,6	20,2
Office Equipment	10,8	6,7	5,4	4,1	4,4
Telecommunication	15,4	24,5	19,9	19,3	6,5
Electronic Components	13,5	5,5	20,8	27,2	44,3
Consumer Electronics	18,8	19,8	16,2	22,6	16,0
Household Appliances	13,0	8,3	6,9	3,0	1,8
Other Electronics	25,6	23,0	13,5	8,2	6,8
Total Electronics Trade	100	100	100	100	100

	versus China				
	1980	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	10,9	5,2	5,4	4,8	9,5
Office Equipment	4,9	5,7	5,0	4,3	4,0
Telecommunication	1,6	1,6	11,4	7,3	25,2
Electronic Components	5,0	3,0	10,5	12,4	6,9
Consumer Electronics	72,0	65,0	51,2	61,5	45,7
Household Appliances	0,7	11,3	9,8	3,5	2,1
Other Electronics	4,9	8,2	6,7	6,3	6,6
Total Electronics Trade	100	100	100	100	100

JAPAN

% Composition of Imports

	versus Malaysia				
	1980	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	0,0	0,4	3,9	14,0	21,9
Office Equipment	0,2	0,0	0,8	9,1	5,2
Telecommunication	0,0	0,0	1,4	1,3	7,1
Electronic Components	82,3	95,3	68,1	40,5	21,3
Consumer Electronics	15,1	2,1	22,0	24,5	37,6
Household Appliances	0,0	0,0	1,9	1,6	2,5
Other Electronics	2,3	2,1	2,0	9,1	4,4
Total Electronics Trade	100	100	100	100	100

	versus Thailand				
	1980	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	0,0	38,5	54,6	46,1	37,0
Office Equipment	0,0	6,1	5,8	5,2	8,0
Telecommunication	0,0	0,2	0,8	6,8	3,6
Electronic Components	3,3	2,9	6,4	7,8	14,0
Consumer Electronics	3,3	2,4	24,0	23,4	24,3
Household Appliances	11,0	0,3	7,9	8,7	9,8
Other Electronics	82,4	49,7	0,6	1,9	3,4
Total Electronics Trade	100	100	100	100	100

	versus China				
	1980	**1985**	**1988**	**1990**	**1993**
Electronic Data Processing	0,0	2,2	0,8	4,3	18,0
Office Equipment	0,0	0,0	17,2	9,8	4,5
Telecommunication	0,0	0,0	2,7	8,1	4,4
Electronic Components	0,0	9,3	0,6	1,6	2,3
Consumer Electronics	61,0	88,2	67,1	55,9	54,3
Household Appliances	2,2	0,2	7,6	7,9	5,8
Other Electronics	36,7	0,1	4,0	12,4	10,8
Total Electronics Trade	100	100	100	100	100

Source: UN and OECD trade data, from SIE World Trade Data Base

5. The emergence of serious regional trade imbalances

The pattern of Japanese international production networks in East Asia has had important implications for Japan's trade links with the region: On the one hand, we can discern a displacement of exports of final products, primarily CE and appliances, from Japan by sales from Asian affiliates of Japanese firms. At the same time, we find that exports of components and production equipment from Japan to East Asia have rapidly expanded. During FY 1994, Japanese exports of electronic components to Asia increased by nearly 33%. We have seen that Japan's reverse imports from the region have also increased, especially for CE and home appliances. Yet, these imports continue to be substantially smaller than the exports of components and production equipment from Japan, producing trade huge imbalances within the region.

If these trade imbalances remain unchecked, this will lead, sooner or later, to increasing regional trade conflicts and to a deterioriating climate for economic relations within the region.
Tables 8 and 9 display the fundamental difference that distinguishes Japan’s trade links with East Asia from those established by the U.S. In 1993, Japan exported almost 28 bn dollars of electronic products to the region, while its imports were a miserably 7.3 bn. This fundamental asymmetry has led to a huge bilateral trade surplus of Japan with East Asia in electronics of almost 21 bn dollars.

The situation is fundamentally different for US trade links with this region. The U.S. imported $ 42.6 bn worth of electronic products from East Asia, almost 6 times the import value of Japan. The U.S. import from East Asia were also substantially larger than its exports ($ 18 bn), with the result that the U.S. ends up with a trade deficit in electronics with East Asia that comes close to $ 25bn.

The product composition of the two trade balances is also different. In the case of the U.S., computer related product show a deficit ($15 bn) that is more than 60 % of the total bilateral U.S. trade deficit, while CE is responsible for roughly another 30%. Both Taiwan and Singapore accounts for the lion’s share of the U.S. deficit in EDP products, while Malaysia is responsible for a significant share of the CE product trade deficit.

In the case of Japan, Table 9 clealry indicates that component exports are by far the main cause for Japan’s trade surplus with East Asia. In 1993, electronics components have accounted for the largest share in Malaysia, Taiwan and Singapore, although in each of these countries the causes for this high dependence on component imports from Japan differ.

Different root causes could explain Japan’s huge bilateral trade surplus with East Asia (Cohen andGuerrieri, 1994). The first one continues to be substantial constraints to imports into the Japanese market. The second one is the relatively closed organization of Japanese international

production networks in East Asia and their peculiar product mix. Both constraints however are now gradually becoming less stringent and East Asia's share in Japanese electronics imports is rapidly increasing (Guerrieri, 1995).

Some observers argue that East Asia's bilateral trade deficit with Japan are unproblematic. One version of this argument purports that due to the so called J-curve effect of FDI[222222222222222], these deficits are likely to decline anyway, once the initial set up phase is over, and the Japanese affiliates begin to increase their local procurement. It is argued in addition that East Asia can benefit from the prevalence of 'triangular trade': as long as its trade surpluses with the U.S. and Europe are larger than its trade deficit with Japan, there should not be any problem.

None of these assumption, however, can be taken for granted. As for the FDI argument, it is not realistic to assume that capital goods imports will decline, once the initial set-up phase is over. In the electronics industry, with its short product cycles and its often quite radical paradigm shifts, a latecomer cannot count on a continuous decline of capital goods imports. Such imports, on the contrary, are likely to increase periodically, with each shift to a new product generation, with each extension of the product mix, and with each shift in the technology paradigm. The same is true for the imports of those key components that are essential for the cost and performance features of a particular product[222222222222222]

As for the 'triangular trade argument', there is also reason to be skeptical. At least in the electronics industry, East Asia trade surpluses with the U.S. and Europe have started to declne, while the region's trade deficit with Japan has continued to increase.

222222222222222 This concept claims that the net exports resulting from the establishment of a foreign affiliate ususally decline at first and then rise. It draws an analogy to the J-curve effect of a currency devaluation.

222222222222222 A recent study by the Sakura Research Institute (Takayasu and Ishizaki, 1995, p.17) shows that, for key components, like ICs and LCDs, Japan's exports to East Asia will continue to surpass by far any such imports from the region and that Japan will be able to sustain for quite some time a significant absolute competitive advantage. This is hardly surprising for anyone familiar with the electronics industry. Imports of key components, in general, are likely to grow periodically and thus tend to follow a similar pattern as that for the more sophisticated capital goods imports. The reason is straightforward: Suppose a country strives to increase local production for a certain key component required for a particular product Pt. And suppose further that sufficiently strong companies exist in the country that can hurdle the substantial entry barriers that characterize the production of such key components - an assumption which surely cannot be taken for granted. Even then, catching-up requires a certain period of time. Even under the best of all circumstances, the latecomer may thus end up in a paradoxical situation: Once he has finally succeeded in producing a substantial part of the key components required for Pt, the industry may already have moved on to the next product generation(s) Pt1 or Pt2, with the result that much of the catching-up efforts may have been in vain.

In short, those who claim that East Asia's bilateral trade deficit with Japan are unproblematic, need to provide evidence that all of the above-mentioned conditions can be met. They also need to provide evidence that each of the affected economies can smoothly adjust to the restructuring requirements that result from these growing trade deficits and that trade frictions can be contained without disruptive policy reactions.

TABLE 8
UNITED STATES: ELECTRONICS TRADE BALANCES
(in absolute terms, US Dollars, 000 Thousands)

versus Taiwan

	1980	1985	1988	1990	1993
Total Electronics Trade	-942.021	-2.450.628	-3.763.370	-3.734.881	-5.539.719
Electronic Data Processing	52.968	-108.159	-501.403	-2.560.724	-4.700.681
Office Equipment	-40.197	-97.381	-222.345	-194.454	-197.976
Telecommunication	27.389	-118.015	-143.167	59.694	-120.854
Electronic Components	-94.382	-105.487	-55.895	33.567	135.610
Consumer Electronics	-675.496	-879.121	-938.561	-534.062	-209.528
Household Appliances	-28.850	-176.231	-203.387	-305.919	-371.563
Other Electronics	-183.453	-966.234	-1.698.612	-232.983	-74.727

versus South Korea

	1980	1985	1988	1990	1993
Total Electronics Trade	-480.845	-1.708.549	-4.053.680	-3.577.635	-4.743.158
Electronic Data Processing	33.546	98.008	148.730	-688.310	-1.641.521
Office Equipment	-14.786	-44.570	-102.664	-47.390	-40.608
Telecommunication	22.474	-12.750	-160.564	-54.255	975
Electronic Components	-150.155	-104.783	-692.345	-931.088	-1.320.754
Consumer Electronics	-377.993	-936.123	-1.647.489	-1.341.049	-1.426.450
Household Appliances	-19.256	-291.097	-518.414	-335.028	-285.339
Other Electronics	25.325	-417.234	-1.080.934	-180.515	-29.461

versus Hong Kong

	1980	1985	1988	1990	1993
Total Electronics Trade	-612.164	-1.300.684	-1.640.157	-1.165.207	84.765
Electronic Data Processing	72.990	-140.270	-71.951	-382.049	-105.593
Office Equipment	-57.386	-23.137	-121.825	-96.168	-70.357
Telecommunication	10.641	-61.003	-109.469	-39.260	5.160
Electronic Components	-33.678	38.144	113.516	270.481	630.570
Consumer Electronics	-455.368	-756.508	-824.011	-602.218	-341.979
Household Appliances	-145.163	-256.439	-242.758	-137.233	-56.249
Other Electronics	-4.200	-101.471	-383.659	-178.760	23.213

versus Singapore

	1980	1985	1988	1990	1993
Total Electronics Trade	-876.075	-1.450.302	-3.313.370	-4.379.202	-5.347.269
Electronic Data Processing	52.187	-460.445	-1.483.527	-3.426.638	-5.600.345
Office Equipment	-25.548	-21.944	-82.171	-85.957	-101.829
Telecommunication	2.997	-11.561	-175.912	-41.427	35.932
Electronic Components	-486.259	-199.623	-355.815	-85.595	805.623
Consumer Electronics	-172.685	-327.405	-418.922	-258.660	-202.536
Household Appliances	-40.983	-135.787	-106.992	-82.697	-89.143
Other Electronics	-205.784	-293.537	-690.031	-398.228	-194.971

TABLE 8 (continued)
UNITED STATES: ELECTRONICS TRADE BALANCES
(in absolute terms, US Dollars, 000 Thousands)

	versus Malaysia				
	1980	**1985**	**1988**	**1990**	**1993**
Total Electronics Trade	-726.754	-509.586	-779.511	-1.461.503	-4.850.028
Electronic Data Processing	7.492	-7.809	27.446	-71.460	-1.248.482
Office Equipment	1.502	851	-1.526	-36.174	-104.596
Telecommunication	2.443	-6.165	-549	-190.509	-272.632
Electronic Components	-691.457	-301.019	-341.357	-151.464	-657.779
Consumer Electronics	-6.101	-115.847	-321.947	-839.813	-2.224.971
Household Appliances	1.589	-12.218	-2.938	-44	-58.706
Other Electronics	-42.222	-67.379	-138.640	-172.039	-282.862

	versus Thailand				
	1980	**1985**	**1988**	**1990**	**1993**
Commercio Totale	-28.531	-2.630	-227.996	-796.548	-1.755.973
Electronic Data Processing	8.094	17.796	-263.373	-407.625	-959.658
Office Equipment	2.123	4.257	1.566	-18.607	-173.642
Telecommunication	2.391	2.157	11.726	-98.862	-217.967
Electronic Components	-60.466	-38.538	48.302	121.742	75.459
Consumer Electronics	1.564	3.311	-15.592	-293.380	-321.759
Household Appliances	2.358	884	-23.673	-112.863	-158.669
Other Electronics	15.405	7.503	13.048	13.047	263

	versus China				
	1980	**1985**	**1988**	**1990**	**1993**
Total Electronics Trade	39.917	200.558	-602.515	-1.774.011	-3.720.944
Electronic Data Processing	28.612	153.514	140.529	74.450	-548.003
Office Equipment	1.864	2.161	-16.905	-57.432	-153.473
Telecommunication	1.452	1.471	-49.889	-242.956	-110.099
Electronic Components	1.026	7.319	5.039	26.914	-1.726
Consumer Electronics	3.228	-19.725	-424.708	-874.753	-1.778.701
Household Appliances	-42	-11.034	-315.011	-619.558	-1.024.541
Other Electronics	3.777	66.852	58.430	-80.676	-104.401

Source: UN and OECD trade data, from SIE World Trade Data Base

TABLE 9
JAPAN: ELECTRONICS TRADE BALANCES
(in absolute terms, US Dollars, 000 Thousands)

versus USA

	1980	1985	1988	1990	1993
Total Electronics Trade	4.060.421	15.955.527	20.866.554	18.941.205	25.276.702
Electronic Data Processing	-380.213	2.069.389	6.279.822	6.207.868	10.483.103
Office Equipment	873.222	2.152.507	2.533.712	2.257.540	3.034.442
Telecommunication	151.035	875.793	1.724.092	1.066.769	1.242.552
Electronic Components	186.135	768.586	1.821.619	1.587.274	3.079.293
Consumer Electronics	2.438.975	7.770.473	5.644.296	5.088.051	4.424.234
Household Appliances	257.311	614.315	319.204	239.916	275.876
Other Electronics	533.956	1.704.464	2.543.809	2.493.787	2.737.202

versus Taiwan

	1980	1985	1988	1990	1993
Total Electronics Trade	356.290	613.630	2.068.941	2.305.375	3.563.598
Electronic Data Processing	21.390	73.963	374.875	431.068	381.925
Office Equipment	18.166	32.065	9.086	43.238	133.287
Telecommunication	32.490	18.677	55.958	62.277	78.992
Electronic Components	110.389	284.107	1.198.601	1.211.023	2.482.180
Consumer Electronics	85.773	107.662	334.227	409.648	279.499
Household Appliances	11.482	26.542	12.239	56.280	78.852
Other Electronics	76.600	70.614	83.955	91.841	128.863

versus South Korea

	1980	1985	1988	1990	1993
Total Electronics Trade	275.094	659.784	1.848.388	1.494.362	1.497.414
Electronic Data Processing	45.461	161.483	362.077	286.181	254.547
Office Equipment	6.295	23.897	87.396	122.675	281.090
Telecommunication	12.770	11.446	-13.353	-29.328	-42.349
Electronic Components	87.826	303.012	1.336.234	1.141.993	1.149.650
Consumer Electronics	42.753	62.326	-45.004	-104.672	-263.289
Household Appliances	13.198	5.510	-18.717	-26.548	-22.462
Other Electronics	66.791	92.110	139.755	104.061	140.227

versus Hong Kong

	1980	1985	1988	1990	1993
Total Electronics Trade	870.249	1.568.342	2.935.488	3.416.044	5.732.422
Electronic Data Processing	29.907	105.001	359.573	438.334	520.526
Office Equipment	62.148	164.309	136.995	167.676	272.484
Telecommunication	7.165	50.161	216.238	166.878	203.624
Electronic Components	172.682	371.163	946.281	898.802	1.924.398
Consumer Electronics	501.516	703.784	946.315	1.295.623	1.868.498
Household Appliances	70.219	79.945	104.209	87.272	127.117
Other Electronics	26.612	93.979	225.877	361.459	815.775

TABLE 9 (continued)
JAPAN: ELECTRONICS TRADE BALANCES
(in absolute terms, US Dollars, 000 Thousands)

	versus Singapore				
	1980	**1985**	**1988**	**1990**	**1993**
Total Electronics Trade	666.204	1.018.144	2.260.815	3.025.373	4.896.330
Electronic Data Processing	13.087	60.287	251.832	191.560	382.807
Office Equipment	37.025	63.297	78.026	116.295	248.690
Telecommunication	33.769	39.621	89.411	128.707	162.766
Electronic Components	105.342	280.962	895.724	1.191.344	2.455.259
Consumer Electronics	372.288	391.740	679.336	1.105.919	1.167.976
Household Appliances	39.664	67.778	64.677	49.575	67.331
Other Electronics	65.029	114.459	201.809	241.973	411.501
	versus Malaysia				
	1980	**1985**	**1988**	**1990**	**1993**
Total Electronics Trade	190.522	347.823	646.259	848.471	1.765.378
Electronic Data Processing	3.867	13.052	22.466	39.043	-33.089
Office Equipment	6.969	11.385	8.959	-10.163	-25.531
Telecommunication	16.453	48.098	11.955	50.412	68.505
Electronic Components	61.740	127.340	484.392	543.130	1.416.968
Consumer Electronics	60.126	88.103	64.665	126.823	194.098
Household Appliances	15.250	26.598	15.878	14.518	1.794
Other Electronics	26.117	33.247	37.944	84.708	142.633
	versus Thailand				
	1980	**1985**	**1988**	**1990**	**1993**
Commercio Totale	87.594	185.520	355.376	564.470	706.242
Electronic Data Processing	2.483	22.423	44.277	-2.772	4.962
Office Equipment	9.475	12.446	18.800	19.991	760
Telecommunication	13.543	45.647	79.659	146.226	70.699
Electronic Components	11.842	10.245	80.571	211.139	561.827
Consumer Electronics	16.493	36.843	54.054	125.427	44.905
Household Appliances	11.428	15.499	23.925	-184	-52.951
Other Electronics	22.330	42.417	54.090	64.643	76.040
	versus China				
	1980	**1985**	**1988**	**1990**	**1993**
Total Electronics Trade	219.632	2.015.664	1.204.532	793.363	1.464.453
Electronic Data Processing	24.242	104.695	68.078	38.632	68.402
Office Equipment	10.781	114.936	50.936	22.450	55.497
Telecommunication	3.595	33.010	143.780	56.271	541.100
Electronic Components	10.990	59.931	133.886	120.143	139.044
Consumer Electronics	158.451	1.309.135	605.004	499.192	598.091
Household Appliances	1.471	227.661	120.087	18.760	340
Other Electronics	10.102	166.296	82.761	37.915	61.979

Source: UN and OECD trade data, from SIE World Trade Data Base

6. Concluding remarks

This paper has analyzed U.S. and Japanese trade links in electronics with East Asia and attempted to relate them to the different features of the international production networks that American and Japanese electronics firms have established in this region. The main findings can be summarized as follows: There are important differences in the trade links that the U.S. and Japan have established with East Asia in the electronics industry, related to the role played by different countries in the region as well as to the product composition of these trade links.

First, East Asia has played a much more prominent role as a source of US electronics imports than it did for Japan. This pattern is now changing, with the result that East Asia has become a major source of Japanese electronics imports. As for US imports from these countries, we find a variety of results which reflect the different stage of development of each of these countries and the different role that each of these locations play as export platforms for the US market. In the case of Japan, we find that there is a group of four countries where one product group dominates Japanes imports and defines the role played by each individual country as a supply base for Japanese firms.

Secondly, U.S. and Japanese electronics exports to East Asia share one common feature: the dominance of electronic components. However, Japanese exports to the region have experienced greater changes over the last one and half decade than US exports. This relects the fact that Japanese electronics firms, until recently, have predominantly relied on exports rather than on international production to generate sales in the region. This, however is now beginning to change: penetrating Asia`s contested growth markets for electronics has become a major objective[222222222222222].

Thirdly, other fundamental differences exist in the logic of integration of American and Japanese companies with East Asia with regard to the product composition of trade links. For the US, the focus clearly is on computer-related products: the growing share of these products in U.S. trade indicates the rapid globalization of the U.S. computer industry and the critical role played by East Asia as a supply base both for final assembly and component manufacturing. For Japan, until very recently, the focus of integration overwhelmingly has been on consumer products. Only recently has Japan begun to broaden the trade product mix by including a variety of products related to the computer and telecommunications equipment industries.

[222222222222222] An account of these and the following recent changes in the Asian production networks of Japanese electronics firms can be found in Ernst, 1997a. For changes in the international production networks of American electronics firms, see Ernst, 1996.

These significant differences of trade patterns that link the U.S. and Japan with East Asian countries can only be partially attributed to traditional comparative advantages based on factor endowments and costs. The paper shows how these observed differences can be better explained by some peculiar features of the international production networks that American and Japanese firms have established in East Asia.

Since the late 1970s, American electronic firms, especially for PC-related products, including a variety of semiconductor devices, have played a pioneering role in establishing international production networks in East Asia, developing new forms of organizing international production that did not necessarily involve equity control. The early lead in the development of new and indirect forms of organizing international production has conveyed substantial competitive advantages to US computer companies. This has set in motion a virtuous circle: By redeploying lower-end stages of the value chain to Asia, American electronics companies were able to concentrate on what they do best, i.e. on product design and the definition of global brand names and architectural standards, and on the control of distribution channels. A focus on such higher stages of the value chain has generated high profit margins, increasing the disposable funds for R&D and investment. This has enabled American companies to stay ahead through aggressive new product development and the creation of new and more sophisticated entry barriers.

In the organization of international production in East Asia, Japan electronics firms have taken a very different approach from American companies: they have focused on very different product groups and markets than American firms, and in the export platform production they have tried to keep their production networks as closed as possible to outsiders, by centralizing almost all strategic decision-making and high value-added activities in Japan. Only since around 1991 have Japanese firms begun to gradually open their Asian production networks, which has led to an increasing localization of component sourcing in Asia, plus increasing exports of production equipment from Japan.

The closed nature of Japanese production networks in Asia has led to an asymmetric trade and investment relationship between Japan and East Asia, leading to serious regional trade imbalances. The result is that East Asia has a huge bilateral trade deficit with Japan. The situation is fundamentally different for the U.S., which has experienced a significant bilateral trade deficit with East Asia in the electronics industry during the past one and half decade, mostly attributable to structural factors such as the greater openness of the U.S. market and to the ‘open organization’ of the U.S. international production networks.

Finally, we have to draw attention to two limitations of this study. First, we have to be very careful in the conclusions on what are the driving forces behind the changes in the region's trade patterns: U.S. and Japanese international production strategies matter, but they are certainly not the only force to be reckoned with. As emphasized in the paper, one should not neglect the important role of international production networks established by electronics firms from Korea, Taiwan, more

recently China, and of course Europe. The result is that we are now dealing with increasingly complex forms of international production networks in the region.

Secondly, the paper provides some empirical materials and defines some stylized facts on the interaction between trade, FDI and international production networks in the electronics industry, by using a set of assumptions that are at this stage rather tentative. In this regard, as outlined at the beginning of the paper, it reflects the infant stage of economic theory on this issue. More rigorous theoretical and empirical analysis is certainly required, and should be inserted in any future research agenda on this topic.

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The Research Programme

The DRUID-research programme is organised in 3 different research themes :

- The firm as a learning organisation

- Competence building and inter-firm dynamics

- The learning economy and the competitiveness of systems of innovation

In each of the three areas there is one strategic theoretical and one central empirical and policy oriented orientation.

Theme A: The firm as a learning organisation

The theoretical perspective confronts and combines the ressource-based view (Penrose, 1959) with recent approaches where the focus is on learning and the dynamic capabilities of the firm (Dosi, Teece and Winter, 1992). The aim of this theoretical work is to develop an analytical understanding of the firm as a learning organisation.

The empirical and policy issues relate to the nexus technology, productivity, organisational change and human ressources. More insight in the dynamic interplay between these factors at the level of the firm is crucial to understand international differences in performance at the macro level in terms of economic growth and employment.

Theme B: Competence building and inter-firm dynamics

The theoretical perspective relates to the dynamics of the inter-firm division of labour and the formation of network relationships between firms. An attempt will be made to develop evolutionary models with Schumpeterian innovations as the motor driving a Marshallian evolution of the division of labour.

The empirical and policy issues relate the formation of knowledge-intensive regional and sectoral networks of firms to competitiveness and structural change. Data on the structure of production will be combined with indicators of knowledge and learning. IO-matrixes which include flows of knowledge and new technologies will be developed and supplemented by data from case-studies and questionnaires.

Theme C: The learning economy and the competitiveness of systems of innovation.

The third theme aims at a stronger conceptual and theoretical base for new concepts such as 'systems of innovation' and 'the learning economy' and to link these concepts to the ecological dimension. The focus is on the interaction between institutional and technical change in a specified geographical space. An attempt will be made to synthesise theories of economic development emphasising the role of science based-sectors with those emphasising learning-by-producing and the growing knowledge-intensity of all economic activities.

The main empirical and policy issues are related to changes in the local dimensions of innovation and learning. What remains of the relative autonomy of national systems of innovation? Is there a tendency towards convergence or divergence in the specialisation in trade, production, innovation and in the knowledge base itself when we compare regions and nations?

The Ph.D.-programme

There are at present more than 10 Ph.D.-students working in close connection to the DRUID research programme. DRUID organises regularly specific Ph.D-activities such as workshops, seminars and courses, often in a co-operation with other Danish or international institutes. Also important is the role of DRUID as an environment which stimulates the Ph.D.-students to become creative and effective. This involves several elements:

- access to the international network in the form of visiting fellows and visits at the sister institutions
- participation in research projects
- access to supervision of theses
- access to databases

Each year DRUID welcomes a limited number of foreign Ph.D.-students who wants to work on subjects and project close to the core of the DRUID-research programme.

External projects

DRUID-members are involved in projects with external support. One major project which covers several of the elements of the research programme is DISKO; a comparative analysis of the Danish Innovation System; and there are several projects involving international co-operation within EU's 4th Framework Programme. DRUID is open to host other projects as far as they fall within its research profile. Special attention is given to the communication of research results from such projects to a wide set of social actors and policy makers.

DRUID Working Papers

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Information for subscribers.

Subscription price for 1997 is 600 DKR (about 20 papers). The rate for single issues is 40 DKR. It is possible to make a commitment to an exchange of papers from related departments or research teams. All correspondence concerning the DRUID Working Papers should be send to:

Pernille Wittrup, Fibigerstræde 4, DK-9220 Aalborg OE
Tel. 45 96 35 82 65, Fax. 45 98 15 60 13 , E-mail: druid-wp@business.auc.dk